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FLOOD INSURANCE STUDY

CITY OF NORTH RICHLAND HILLS, TEXAS
TARRANT COUNTY

REVISED:
DECEMBER 16, 1998

ORIGINAL

Federal Emergency Management Agency

COMMUNITY NUMBER - 480607

COMPLETED

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance study purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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PUBLISHED SEPARATELY:

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FLOOD INSURANCE STUDY
CITY OF NORTH RICHLAND HILLS, TEXAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of North Richland Hills, Tarrant County, Texas, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study represent a revision of the original analyses prepared by the Soil Conservation Service (SCS) for the Federal Emergency Management Agency (FEMA). This work was completed in 1980.

A revision was prepared by the Fort Worth District of the U. S. Army Corps of Engineers (COE) for FEMA, under Inter-Agency Agreement No. EMW-E-0941, Project Order No. 1. This work was completed in December 1983.

In this revision, the hydrologic and hydraulic analyses for Stream CB-1 were prepared by Anderson Engineers, Inc., and Knowlton-English-Flowers, Inc. This work was completed in October 1987.

1.3 Coordination

On May 13, 1982, an initial Consultation and Coordination Officer's (CCO) meeting was held with representatives of FEMA, the city, and the COE to identify the streams to be studied by detailed methods. Information furnished by the city included topographic maps, a city

limits map, plans for proposed flood control projects, and a master plan. The Texas Department of Highways and Public Transportation furnished bridge data as requested. On December 10, 1984, the results of the study were reviewed at final CCO meeting held with representatives of FEMA, the city, and the COE.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of North Richland Hills, Tarrant County, Texas. The area of study is shown on the Vicinity Map (Figure 1).

The original study was revised to reflect changes in the watershed conditions (more urbanized), the addition of new bridges, and the channelization of some of the streams. This revision was performed to incorporate channel improvements on stream CB-1, and the addition of 0.2 mile of detailed study reflecting the installation of storm drains under Hewitt Street. Table 1, "Scope of Study," lists all flooding sources studied by detailed methods.

TABLE 1 - SCOPE OF STUDY

Stream	Downstream Limit	Upstream Limit
Big Fossil Creek	Stream Mile 3.3	Stream Mile 6.1
Stream BF-6	Confluence with Big Fossil Creek, Stream Mile 0.0	Stream Mile 0.5
Stream BF-7	Confluence with Big Fossil Creek, Stream Mile 0.0	Stream Mile 0.2
Calloway Branch	Stream Mile 2.5	Stream Mile 7.4
Stream CB-1	Confluence with Calloway Branch, Stream Mile 0.0	Stream Mile 1.8
Stream CB-1 Diversion	Confluence with Calloway Branch, Stream Mile 0.0	Confluence with Stream CB-1, Stream Mile 0.4
Stream CB-2	Confluence with Calloway Branch, Stream Mile 0.0	Stream Mile 1.4
Little Bear Creek	Stream Mile 10.3	Stream Mile 14.4
Stream LB-1	Confluence with Little Bear Creek, Stream Mile 0.0	Stream Mile 0.8
Stream LB-2	Confluence with Little Bear Creek, Stream Mile 0.0	Stream Mile 1.1

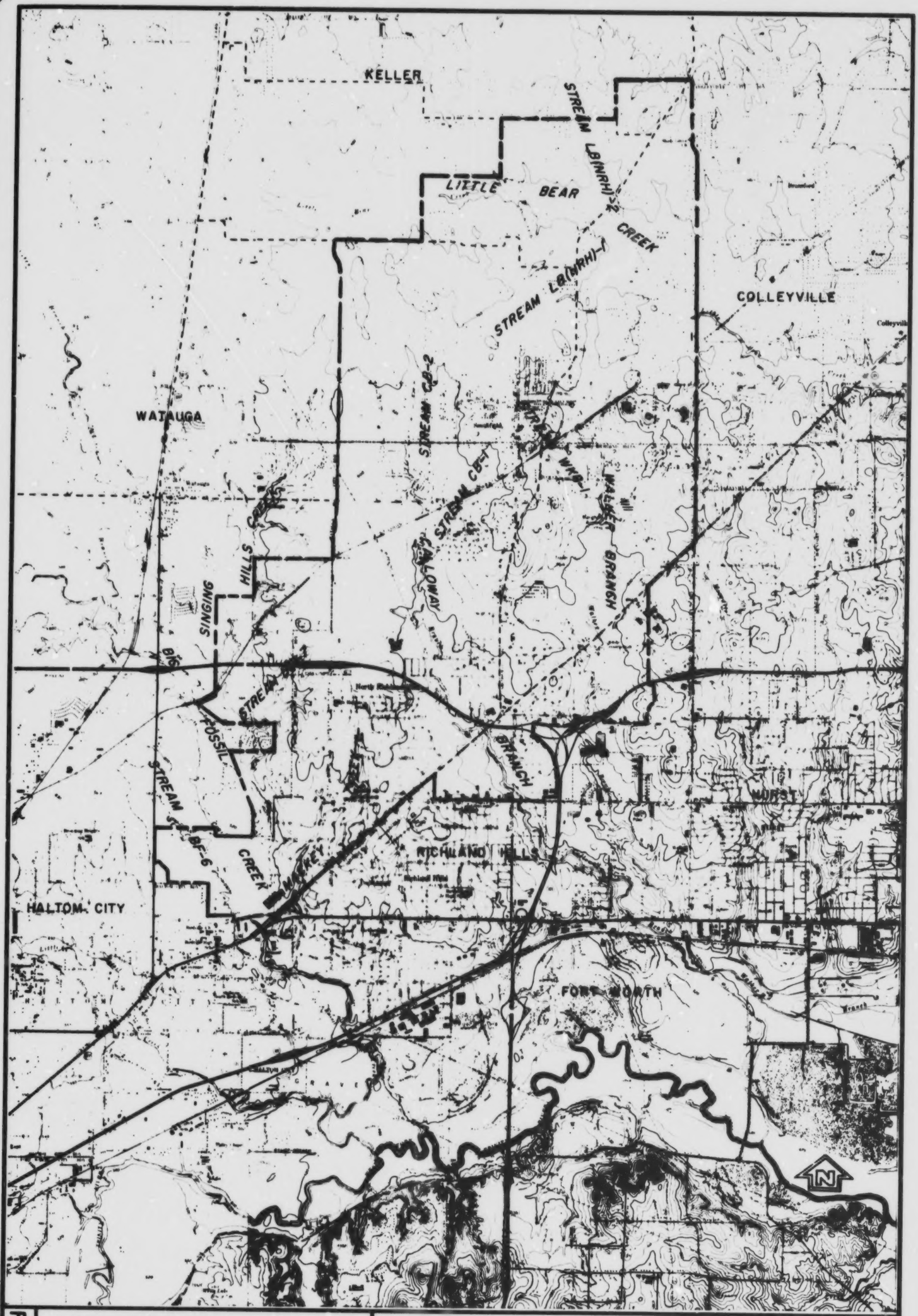

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

APPROXIMATE SCALE

0 4000 8000 12000 16000 FEET

VICINITY MAP

TABLE 1 - SCOPE OF STUDY - continued

Stream	Downstream Limit	Upstream Limit
Mackey Creek	Stream Mile 0.5	Stream Mile 2.4
Mackey Creek Diversion North	Confluence with Big Fossil Creek, Stream Mile 0.0	Confluence with Mackey Creek Diversion South, Stream Mile 0.5
Mackey Creek Diversion South	Stream Mile 0.1	Confluence with Mackey Creek, Stream Mile 0.5
Singing Hills Creek	Confluence with Big Fossil Creek, Stream Mile 0.0	Stream Mile 1.9
Walker Branch	Stream Mile 7.7	Stream Mile 11.3
Stream WKB-1	Confluence with Walker Branch, Stream Mile 0.0	Stream Mile 0.4

An area of shallow flooding between Stream CB-1 and Stream CB-1 Diversion was also studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

Portions of Stream BF-7, Calloway Branch, Little Bear Creek, Stream LB-1, Stream LB-2, Mackey Creek, Singing Hills Creek, Walker Branch, and Stream WKB-1 were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of North Richland Hills.

2.2 Community Description

The City of North Richland Hills is located in the northeastern portion of Tarrant County in north-central Texas, approximately 13 miles northeast of downtown Fort Worth. It is bordered by the City of Richland Hills to the south, the Cities of Hurst and Colleyville to the east, the Cities of Haltom City and Watauga to the west, and the City of Keller to the north. The 1980 population of North Richland Hills was 30,592 (References 1 and 2). The total land area contained within the corporate limits is approximately 16 square miles.

Big Fossil Creek, with a drainage area of approximately 53.7 square miles at the gage located below Grapevine Highway, flows southeast into the West Fork Trinity River.

Stream BF-6, a tributary of Big Fossil Creek, flows from west to east within the corporate limits. It has a drainage area of 0.9 square mile.

Stream BF-7, a tributary of Big Fossil Creek with a drainage area of approximately 0.6 square mile, flows to the south and west.

Calloway Branch has a drainage area of approximately 6.2 square miles at the city limits. It flows south into the City of Richland Hills.

Stream CB-1, a tributary to Calloway Branch with a drainage area of approximately 0.8 square mile, flows southwest. Stream CB-1 Diversion is approximately 1,000 feet long and leaves Stream CB-1 approximately 1,950 from the confluence of Stream CB-1 with Calloway Branch.

Stream CB-2 has a drainage area of approximately 0.8 square mile and flows south into Calloway Branch.

Little Bear Creek flows southeast and has a drainage area of 8.2 square miles at the city limits.

Stream LB-1, a tributary to Little Bear Creek with a drainage area of approximately 0.7 square mile, flows east.

Stream LB-2, also a tributary to Little Bear Creek, has a drainage area of approximately 0.7 mile and flows southeast.

Mackey Creek, with a drainage area of approximately 1 square mile, flows southwest for approximately 1.7 miles until it splits into two separate flow areas through a shopping center parking lot. The two areas were studied as individual channel from above the shopping center to its confluence with Big Fossil Creek.

Mackey Creek Diversion North branches from Mackey Creek Diversion South approximately 1,850 feet from where the South Diversion departs from Mackey Creek. Mackey Creek Diversion South is approximately 2,100 feet long and departs from Mackey Creek approximately 3,000 feet from where Mackey Creek flows into Big Fossil Creek.

Singing Hills Creek has a drainage area of approximately 5.6 square miles and flows south into Big Fossil Creek.

Walker Branch, with a drainage area of approximately 3.3 square miles, flows south.

Stream WKB-1, a tributary to Walker Branch with a drainage area of approximately 0.4 square mile, flows southeast.

The climatological data at Fort Worth are considered indicative of the conditions prevailing in the region. The average rainfall was 32.30 inches for the last 10-year period. The maximum and minimum rainfall occurring during the last 57 years was 51.03 inches in 1932 and 17.91 inches in 1921, respectively. The mean relative humidity is 65 percent, and the average temperature is 65.8 degrees Fahrenheit (Reference 3).

2.3 Principal Flood Problems

Generally, the major floods experienced in the vicinity are produced by heavy rainfall from frontal type storms that occur in the spring and summer months. Major flooding can be produced by the intense rainfall usually associated with localized thunderstorms, which can occur at any time during the year but are more prevalent in the spring and summer months.

Major flooding in recent years has occurred in North Richland Hills on most of the streams studied. Calloway Branch experienced flooding during the storms of October 1971, September 1974, and October 1981. Walker Branch also experienced flooding in October 1981. Big Fossil Creek and the lower end of Mackey Creek have a long record of devastating floods.

Figure 2 shows potential 100- and 500-year flood heights along Walker Branch.

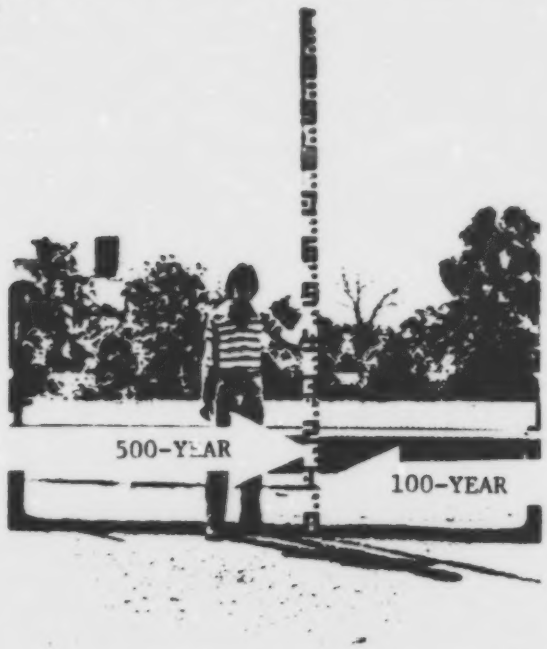

Figure 2 - Potential 100- and 500-year flood heights on Walker Branch at Harwood Road.

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2.4 Flood Protection Measures

Non-structural measures of flood protection in the form of land-use regulations are being used to aid in the prevention of future flood damage within the city.

An improvement on Big Fossil Creek includes a channel-levee system through Richland Hills and a channel straightening project near Glenview Drive, both of which affect flood elevations in North Richland Hills. Walker Branch has been channelized downstream from Harwood Road and upstream from State Route 26. The Mackey Creek channel is improved from Richland Plaza Drive to Onyx Drive North and from Rufe Snow Drive to Manor Drive. Calloway Branch has been improved and modified by channel projects in a piecemeal fashion for most of its length, and the channels of stream CB-1 and CB-2 are improved.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

The computer program NUDALLAS was used in developing the hydrology for this study (Reference 4). The watershed was divided into sub-areas, and synthetic unit and flood hydrographs were developed at selected locations. Technical Paper No. 40 and Technical Memorandum

NWS Hydro-35 were used in developing the 10-, 50-, and 100-year frequency storms (References 5 and 6). The 500-year storm was based on extrapolated data. Peak discharge-frequency values were computed for selected locations. Routing of the flood hydrographs through each sub-basin reach was accomplished using a modified Puls reservoir routing. The COE HEC-2 step-backwater computer program provided the elevation-discharge-storage relationships for each reach on all streams studied by detailed methods (Reference 7).

A summary of the drainage area-peak discharge relationships for the flooding sources studied by detailed methods is shown in Table 2, "Summary of Discharges." Flows from Stream CB-2 are included for Calloway Branch at stream stations 34,500 and 35,700. All flows not diverted at Bogart Avenue are included for Stream CB-1 at its confluence with Calloway Branch. All non-diverted flows are included for Mackey Creek at State Highway 26.

TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
BIG FOSSIL CREEK					
At U. S. Geological Survey (USGS) gage downstream from State Route 183	53.7	19,350	26,400	29,300	35,800
At confluence of Stream BFC-6	51.5	19,700	26,500	29,350	35,500
At confluence of Singing Hills Creek	49.5	20,100	26,600	29,400	35,250
STREAM BF-6					
At confluence with Big Fossil Creek[1]	0.9	2,010	2,740	3,070	3,800
At State Highway 377[1]	0.5	1,290	1,750	1,960	2,460
STREAM BF-7					
At confluence with Big Fossil Creek[1]	0.6	1,380	1,870	2,090	2,460
CALLOWAY BRANCH					
At Glenview Drive	6.2	6,250	8,470	9,610	12,430
At North Loop 820	5.0	5,600	7,550	8,450	10,580
Below confluence of Stream CB-1	3.3	4,990	6,460	7,120	8,810
Above confluence of Stream CB-1	2.6	4,560	5,840	6,430	7,930
At St. Louis-Southwestern Railroad	2.3	4,300	5,670	6,240	7,710
Below confluence of Stream CB-2	2.0	3,830	5,040	5,580	7,030
At Stream Station 34,500	1.1	2,200	2,350	3,140	3,870

[1]Located outside corporate limits

TABLE 2 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
CALLOWAY BRANCH (continued)					
At Stream Station 35,700	0.87	1,810	2,350	2,580	3,180
At Hightower Drive	0.43	920	1,130	1,290	1,550
At Stream Station 37,600	0.35	740	950	1,040	1,250
At Starnes Road	0.26	550	700	760	920
STREAM CB-1					
At confluence with Calloway Branch	0.75	560	780	880	1,130
At Bogart Drive	0.75	1,090	1,500	1,670	2,120
At Stream Station 3,000	0.55	900	1,220	1,350	1,710
At St. Louis-Southwestern Railroad	0.38	750	990	1,100	1,380
At Chapman Drive	0.29	560	740	820	1,040
At Stream Station 8,000	0.20	400	530	590	740
At Storm Drain Outlet	0.18	361	478	553	668
Above Buck Street	0.15	302	401	446	560
Above Frankie Street	0.13	262	343	388	487
STREAM CB-1 DIVERSION					
At confluence with Stream CB-1	*	530	720	790	990
STREAM CB-2					
At Hightower Drive	0.45	890	1,170	1,290	1,630
At Stream Station 5,600	0.19	380	490	550	690
At Stream Station 6,100	0.17	330	430	480	610
At Stream Station 6,800	0.13	260	340	370	470
At Starnes Road	0.11	220	290	330	410
LITTLE BEAR CREEK					
At St. Louis-Southwestern Railroad[1]	8.2	4,400	6,400	7,400	9,400
At confluence of Stream LB-1	6.1	3,450	5,100	5,800	7,600
At Davis Boulevard (FM 1938)	4.6	2,750	4,000	4,500	5,900
At Stream Station 71,750	3.0	2,500	3,550	4,000	5,100

[1]Located outside corporate limits
*Data not available

TABLE 2 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
STREAM LB-1					
At confluence with Little Bear Creek	0.72	1,170	1,560	1,740	2,190
STREAM LB-2					
At confluence with Little Bear Creek	0.69	600	800	900	1,320
At Stream Station 1,250	0.69	900	1,230	1,370	1,730
At Stream Station 4,100	0.53	790	1,080	1,200	1,520
MACKEY CREEK					
At State Route 26 (Grapevine Highway)[1]	0.85	530	520	510	470
At Richland Plaza Drive	0.85	1,930	2,600	2,910	3,480
At Stream Station 7,000	0.56	1,570	2,110	2,360	2,820
At Briley Drive	0.30	1,140	1,530	1,720	2,050
MACKEY CREEK DIVERSION NORTH					
At Mackey Creek Diversion South	*	280	470	570	780
MACKEY CREEK DIVERSION SOUTH					
Below Mackey Creek Diversion North	*	1,120	1,610	1,830	2,230
At Mackey Creek	*	1,400	2,080	2,400	3,010
SPRING HILLS CREEK					
At confluence with Big Fossil Creek[1]	5.6	6,550	9,400	10,550	13,450
At Stream Station 3,750	5.3	6,800	9,300	10,350	13,150
WALKER BRANCH					
At State Route 121[1]	3.29	3,700	4,550	4,770	5,810
At State Route 26 (Grapevine Highway)	2.22	2,550	3,470	3,920	4,990
At Stream Station 50,000	1.89	2,360	3,200	3,640	4,650

[1] Located outside corporate limits
* Data not available

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TABLE 2 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WALKER BRANCH (continued)					
Below confluence of Stream WKB-1	1.47	2,130	2,870	3,280	4,220
Above confluence of Stream WKB-1	1.07	1,570	2,060	2,310	3,000
At Martin Drive	0.99	1,500	1,970	2,210	2,860
At private road crossing	0.96	1,470	1,940	2,170	2,800
At Main Street	0.91	1,430	1,880	2,100	2,710
At Stream Station 56,300	0.71	1,260	1,660	1,850	2,350
At St. Louis-Southwestern Railroad	0.63	1,190	1,580	1,750	2,210
At Stream Station 57,900	0.28	800	1,060	1,180	1,490
At Stream Station 58,500	0.17	620	820	910	1,150
At Brookview Drive	0.14	570	750	840	1,060
At Hightower Drive	0.09	440	590	650	830
STREAM WKB-1					
At confluence with Walker Branch	0.40	660	880	980	1,240

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for the backwater analyses were field surveyed. Cross sections were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer

program (Reference 7). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Starting water-surface elevations for Calloway Branch were determined using a known water-surface elevation from the Flood Insurance Study for the City of Richland Hills (Reference 8). Starting water-surface elevations for Little Bear Creek were determined using a known water-surface elevation from the Flood Insurance Study for the City of Colleyville (Reference 9). Starting water-surface elevations for Mackey Creek were determined using an elevation versus discharge curve for the State Route 183 box culvert. This method assumed critical depth inside the culvert, adding only entrance losses. For the remaining streams studied by detailed methods, starting water-surface elevations were determined by the slope/area method.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the streams and floodplain areas. The channel and overbank "n" values for the streams studied by detailed methods are shown in the following tabulation:

Stream	Channel "n"	Overbank "n"
Big Fossil Creek	0.035-0.065	0.040-0.120
Stream BF-6	0.050-0.060	0.075-0.085
Stream BF-7	0.050	0.060-0.065
Calloway Branch	0.020-0.055	0.040-0.090
Stream CB-1	0.020-0.050	0.060-0.090
Stream CB-1 Diversion	0.035	0.060-0.080
Stream CB-2	0.040-0.055	0.070-0.090
Little Bear Creek	0.030-0.055	0.030-0.090
Stream LB-1	0.045-0.070	0.060-0.090
Stream LB-2	0.040-0.070	0.040-0.090
Mackey Creek	0.020-0.070	0.025-0.090
Mackey Creek Diversion North	0.030-0.050	0.030-0.060
Mackey Creek Diversion South	0.020-0.050	0.020-0.060
Singing Hills Creek	0.040-0.055	0.050-0.075
Walker Branch	0.025-0.065	0.025-0.090
Stream WKB-1	0.050	0.060

Stream CB-1 overflows its watershed boundaries to the east and north of Stream CB-1 Diversion, causing a shallow flooding area.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus

considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing floodplain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For the flooding sources studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (Reference 10). In this revised study, the flood boundaries on Stream CB-1 were delineated using data submitted by Anderson Engineers, Inc., and Knowlton-English-Flowers, Inc.

For the streams studied by approximate methods, the 100-year floodplain boundaries were delineated using the previous Flood Insurance Study for North Richland Hills (Reference 11). Approximate flood boundaries were also estimated using typical depths and widths from area streams and known flood depths and widths from past flood experience.

The 100- and 500-year floodplain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway

fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the floodplain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway widths for Big Fossil Creek, Mackey Creek Diversion South, and Singing Hills Creek extend beyond the corporate limits.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 3 for certain downstream cross sections of Stream BF-7 are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the City of North Richland Hills.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Big Fossil Creek								
A	18,140[1]	496	4,671	6.3	515.9	515.9	516.2	0.3
B	19,861[1]	1,250	9,333	3.1	519.6	519.6	520.3	0.7
C	20,805[1]	1,355	10,894	2.7	520.3	520.3	521.0	0.7
D	26,830[1]	1200/25[4]	9,345	3.1	530.6	530.6	531.4	0.8
E	29,400[1]	550/140[4]	5,769	5.1	536.4	536.4	537.1	0.7
F	30,830[1]	550/290[4]	5,462	5.4	539.3	539.3	540.0	0.7
Stream BF-6								
A	1,120[2]	90	578	5.3	529.9	529.9	530.0	0.1
B	1,960[2]	80	522	5.9	539.7	539.7	540.2	0.5
Stream BF-7								
A	580[2]	65	409	5.1	535.6	531.9[5]	531.9	0.0
B	1,130[2]	50	243	8.6	535.6	535.2[5]	535.2	0.0
Calloway Branch								
A	15,500[3]	126	1,088	8.8	563.9	563.9	564.8	0.9
B	17,150[3]	178	1,485	6.5	569.9	569.9	570.3	0.4
C	18,500[3]	100	912	9.3	575.5	575.5	576.5	1.0
D	20,660[3]	200	1,029	8.2	583.4	583.4	584.4	1.0
E	22,630[3]	300	1,918	4.4	591.8	591.8	592.6	0.8
F	23,720[3]	350	1,584	5.3	594.1	594.1	594.6	0.5

[1]Feet above confluence with West Fork Trinity River
[2]Feet above confluence with Big Fossil Creek
[3]Feet above confluence with Walker Branch
[4]Width/width within corporate limits
[5]Elevation computed without consideration of backwater from Big Fossil Creek

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

FLOODWAY DATA

BIG FOSSIL CREEK, STREAM BF-6,
STREAM BF-7, CALLOWAY BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Calloway Branch (continued)								
G	26,830[1]	169	1,157	6.2	600.3	600.3	600.9	0.6
H	28,240[1]	140	911	7.1	604.9	604.9	605.2	0.3
I	30,320[1]	175	1,496	3.7	614.0	614.0	614.4	0.4
J	31,760[1]	154	1,005	5.6	616.5	616.5	617.2	0.7
K	36,360[1]	175	491	2.6	642.0	642.0	642.7	0.7
L	36,970[1]	125	359	2.9	644.1	644.1	645.1	1.0
M	38,200[1]	28	142	7.3	649.7	649.7	650.6	0.9
N	39,200[1]	23	74	10.3	658.1	658.1	658.1	0.0
Stream CB-1								
A	700[2]	121	318	2.1	605.1	605.1	605.9	0.8
B	2,540[2]	200	322	5.2	616.1	616.1	616.6	0.5
C	3,700[2]	201	337	4.0	623.4	623.4	624.4	1.0
D	5,430[2]	31	120	9.2	633.8	633.8	633.8	0.0
E	6,950[2]	35	113	7.2	642.0	642.0	642.0	0.0
F	7,800[2]	27	95	8.6	650.8	650.8	650.8	0.0
G	9,000[2]	54	61	4.6	660.2	660.2	660.3	0.1
Stream CB-2								
A	4,130[2]	250	407	3.2	639.1	639.1	640.0	0.9
B	5,120[2]	100	281	4.6	648.9	648.9	649.8	0.9
C	6,100[2]	48	74	6.5	659.0	659.0	659.3	0.3
D	7,330[2]	50	66	5.0	670.5	670.5	671.0	0.5

[1]Feet above confluence with Walker Branch
[2]Feet above confluence with Calloway Branch

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

FLOODWAY DATA

CALLOWAY BRANCH, STREAM CB-1, AND STREAM CB-2

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Little Bear Creek								
A	56,350[1]	420	2,815	2.6	615.5	615.5	616.4	0.9
B	58,000[1]	400	2,758	2.7	617.7	617.7	618.7	1.0
C	60,920[1]	399	2,075	2.8	625.2	625.2	626.0	0.8
D	63,220[1]	520	2,469	2.3	628.8	628.8	629.5	0.7
E	66,925[1]	301	1,993	2.3	637.0	637.0	637.1	0.1
F	68,850[1]	250	1,274	3.5	640.8	640.8	641.4	0.6
G	70,100[1]	220	1,597	2.8	646.2	646.2	647.1	0.9
H	72,300[1]	200	874	4.6	651.5	651.5	652.2	0.7
I	74,320[1]	270	1,309	3.1	658.7	658.7	659.0	0.3
Stream LB-1								
A	1,570[2]	121	536	3.2	630.7	630.7	631.6	0.9
B	2,390[2]	60	318	5.5	633.9	633.9	634.5	0.6
C	3,100[2]	50	380	4.2	638.0	638.0	638.5	0.5
D	4,160[2]	80	292	5.4	647.8	647.8	648.8	1.0
Stream LB-2								
A	1,520[2]	165	736	1.9	634.7	634.7	635.6	0.9
B	2,740[2]	120	402	3.4	640.5	640.5	640.5	0.0
C	4,100[2]	140	297	4.6	649.9	649.9	650.9	1.0
D	5,100[2]	130	258	4.7	656.5	656.5	656.9	0.4
E	5,960[2]	90	213	5.5	662.7	662.7	663.7	1.0

[1]Feet above confluence with Big Bear Creek
[2]Feet above confluence with Little Bear Creek

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOODWAY DATA

LITTLE BEAR CREEK, STREAM LB-1, AND STREAM LB-2

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Mackey Creek								
A	3,730	90	490	5.9	541.5	541.5	542.1	0.6
B	5,530	155	374	7.8	553.9	553.9	553.9	0.0
C	6,650	121	633	4.6	564.1	564.1	565.0	0.9
D	7,650	150	969	2.4	572.4	572.4	573.3	0.9
E	9,630	161	658	3.6	586.9	586.9	587.5	0.6
F	10,880	275	772	2.2	595.6	595.6	596.2	0.6
G	11,615	175	237	7.3	598.2	598.2	598.9	0.7
Mackey Creek Diversion North								
A	1,600	292	192	3.0	520.5	520.5	520.5	0.0
B	2,165	108	103	5.5	527.6	527.6	527.6	0.0
Mackey Creek Diversion South								
A	900	400/380[2]	354	5.2	520.3	520.3	520.3	0.0
B	1,700	165	270	6.8	527.8	527.8	527.8	0.0

[1]Feet above confluence with Big Fossil Creek
[2]Width/width within corporate limits

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOODWAY DATA

MACKEY CREEK, MACKEY CREEK DIVERSION NORTH, AND MACKEY CREEK DIVERSION SOUTH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						(FEET NGVD)		
Singing Hills Creek								
A	2,160[1]	211	1,245	8.5	544.2	544.2	544.8	0.6
B	2,820[1]	350	3,222	3.3	551.0	551.0	551.8	0.8
C	3,930[1]	350	1,997	5.3	552.8	552.8	553.5	0.7
D	4,850[1]	221	1,578	6.7	556.9	556.9	557.6	0.7
E	6,070[1]	219	1,552	6.8	562.3	562.3	563.2	0.9
F	8,300[1]	220/70[3]	1,525	6.9	574.0	574.0	574.8	0.8
Walker Branch								
A	41,710[2]	200	1,812	2.6	566.6	566.6	566.7	0.1
B	43,740[2]	65	447	8.8	571.6	571.6	571.6	0.0
C	45,180[2]	190	1,857	2.1	580.5	580.5	580.9	0.4
D	46,730[2]	193	1,043	3.8	581.0	581.0	581.4	0.4
E	49,080[2]	200	1,261	2.9	592.1	592.1	592.8	0.7
F	51,560[2]	250	1,040	3.2	600.9	600.9	601.8	0.9
G	53,380[2]	200	844	2.7	608.1	608.1	608.6	0.5
H	55,520[2]	125	542	3.9	616.4	616.4	617.4	1.0
I	57,130[2]	80	254	6.9	622.7	622.7	623.6	0.9
J	57,940[2]	75	314	3.8	627.6	627.6	628.6	1.0
K	59,120[2]	59	304	2.8	635.0	635.0	635.3	0.3

[1]Feet above confluence with Big Fossil Creek
[2]Feet above confluence with West Fork Trinity River
[3]Width/width within corporate limits

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOODWAY DATA

SINGING HILLS CREEK AND WALKER BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Stream WKB-1								
A	650	84	180	5.5	609.6	609.6	620.2	0.6
B	1,195	149	185	5.3	615.1	615.1	616.0	0.9
C	2,075	210	321	3.0	621.0	621.0	622.0	1.0

[1]Feet above confluence with Walker Branch

TABLE 3

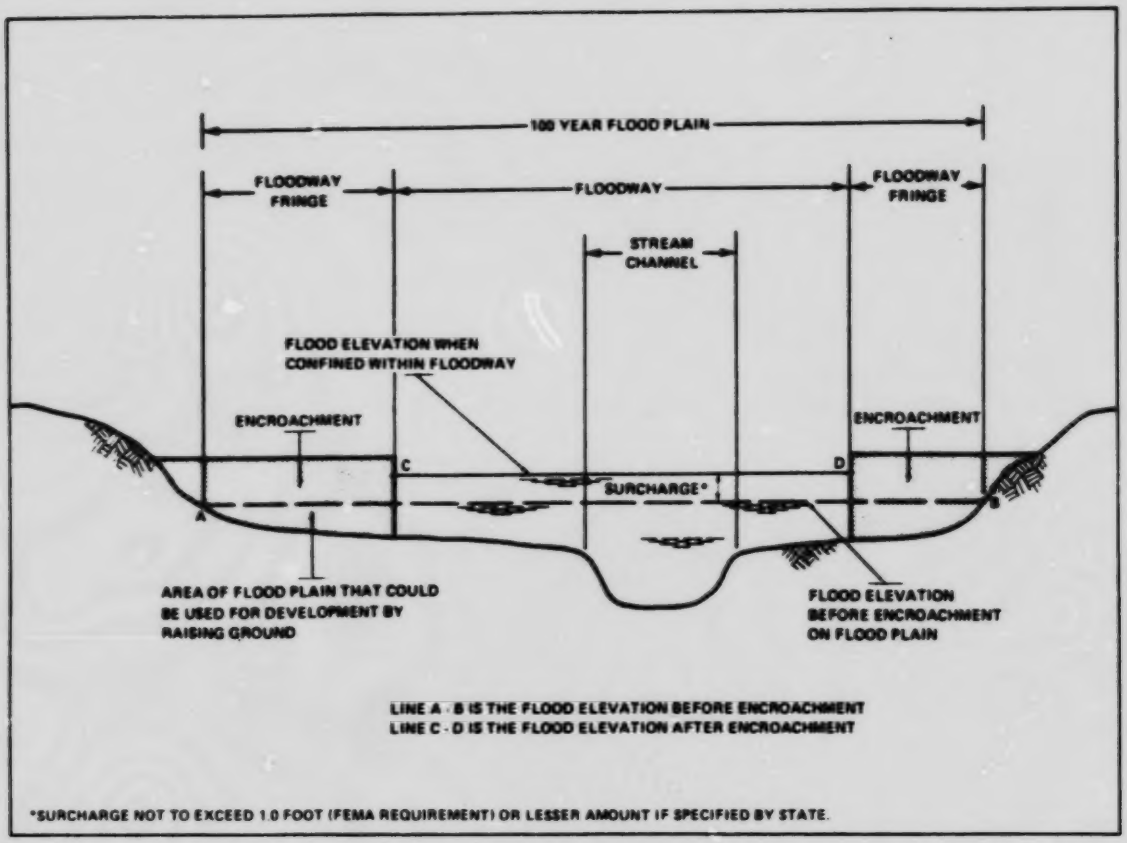
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOODWAY DATA

STREAM WKB-1


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC Figure 3

5.1 Reach Determinations

Reaches are defined as sections of floodplain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

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The locations of the reaches determined for the flooding sources of the City of North Richland Hills are shown on the Flood Profiles (Exhibit 1) and summarized in Table 4.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one- half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zone A0:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown but no FHFs are determined.
Zone A1, A2, A3, A4, A5, A8, and A14:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Big Fossil Creek							
Reach 1	05,07	-2.4	-0.6	+1.4	025	A5	Varies
Stream BF-6							
Reach 1	07	-1.2	-0.3	+0.6	010	A2	Varies
Calloway Branch							
Reach 1	05	-1.6	-0.4	+1.0	015	A3	Varies
Reach 2	05	-1.9	-0.6	+1.2	020	A4	Varies
Reach 3	03,05	-1.3	-0.4	+0.7	015	A3	Varies
Reach 4	03	-0.4	-0.1	+0.3	005	A1	Varies
Stream CB-1							
Reach 1	03,05	-0.6	-0.1	+0.3	005	A1	Varies
Reach 2	03	-1.0	-0.3	+0.7	010	A2	Varies
Sheet Flow Area	03	Shallow Flooding - Average Depth 1 Foot				A0	—

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

FLOOD INSURANCE ZONE DATA

BIG FOSSIL CREEK, STREAM BF-6, CALLOWAY BRANCH, AND STREAM CB-1

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Stream CB-1 Diversion							
Reach 1	03	-0.4	-0.1	+0.3	005	A1	Varies
Stream CB-2							
Reach 1	03	-1.2	-0.3	+0.7	010	A2	Varies
Reach 2	03	-0.3	-0.1	+0.2	005	A1	Varies
Little Bear Creek							
Reach 1	01	-1.3	-0.3	+0.7	015	A3	Varies
Stream LB-1							
Reach 1	01	-0.7	-0.2	+0.4	005	A1	Varies
Stream LB-2							
Reach 1	01	-0.5	-0.1	+0.2	005	A1	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOOD INSURANCE ZONE DATA

STREAM CB-1 DIVERSION, STREAM CB-2, LITTLE BEAR CREEK, STREAM LB-1, AND STREAM LB-2

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Mackey Creek Reach 1	05,07	-0.8	-0.2	+0.4	010	A2	Varies
Mackey Creek Diversion North Reach 1	07	-0.3	-0.1	+0.2	005	A1	Varies
Mackey Creek Diversion South Reach 1	07	-0.4	-0.1	+0.2	005	A1	Varies
Singing Hills Creek Reach 1	05	-1.6	-0.4	+0.8	015	A3	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOOD INSURANCE ZONE DATA

MACKEY CREEK, MACKEY CREEK DIVERSION NORTH
MACKEY CREEK DIVERSION SOUTH,
AND SINGING HILLS CREEK

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Walker Branch							
Reach 1	05	-7.2	-0.4	+0.9	070	A14	Varies
Reach 2	05	-4.2	-0.5	+0.8	040	A8	Varies
Reach 3	03,05	-1.6	-0.4	+0.9	015	A3	Varies
Reach 4	03	-0.8	-0.2	+0.5	010	A2	Varies
Stream WKB-1							
Reach 1	03	-0.3	-0.1	+0.2	005	A1	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOOD INSURANCE ZONE DATA

WALKER BRANCH, AND STREAM WKB-1

Zone C: Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 4.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of North Richland Hills is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Flood Insurance Studies for the Cities of Richland Hills, Colleyville, Keller, Watauga, Haltom City, and Hurst have been completed (References 8, 9, 12, 13, 14, and 15). Due to the scope of this revision, those studies were not rechecked for agreement with this study. Based on the results of the previous studies, this study is assumed to be in agreement with those studies.

Due to its more up-to-date nature, this study supersedes the previous Flood Insurance Study for the City of North Richland Hills (Reference 11).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, the Natural and Technological Hazards Division, Federal Regional Center, 800 North Loop 288, Denton, Texas 76201-3698.

8.0 BIBLIOGRAPHY AND REFERENCES

1. U. S. Department of Commerce, Bureau of the Census, 1980 Census of Population, Number of Inhabitants, Texas, Washington, D. C., U. S. Government Printing Office, 1981.

2. A. H. Belo Corporation, Texas Almanac, 1982-1983, 1981.

3. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, Monthly and Annual Climatological Data for State (Texas), Asheville, North Carolina, National Climatic Center.

4. U. S. Army Corps of Engineers, Fort Worth District, Computer Program NUDALLAS, Fort Worth, Texas, Revised September 1982.

5. U. S. Department of Commerce, Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States, Washington, D. C., 1961, Revised 1963.

6. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Technical Memorandum NWS Hydro-35, Five-to 60-Minute Precipitation Frequency for the Eastern and Central United States, Washington, D. C., June 1977.

7. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, January 1981.

8. Federal Emergency Management Agency, Flood Insurance Study, City of Richland Hills, Tarrant County, Texas, Washington, D. C., July 3, 1985.

9. Federal Emergency Management Agency, Flood Insurance Study, City of Colleyville, Tarrant County, Texas, Washington, D. C., December 1, 1982.

10. City of North Richland Hills, Topographic Maps compiled from aerial photographs, Scale 1:9,600, Contour Interval 2 Feet: North Richland Hills, Texas, 1982.

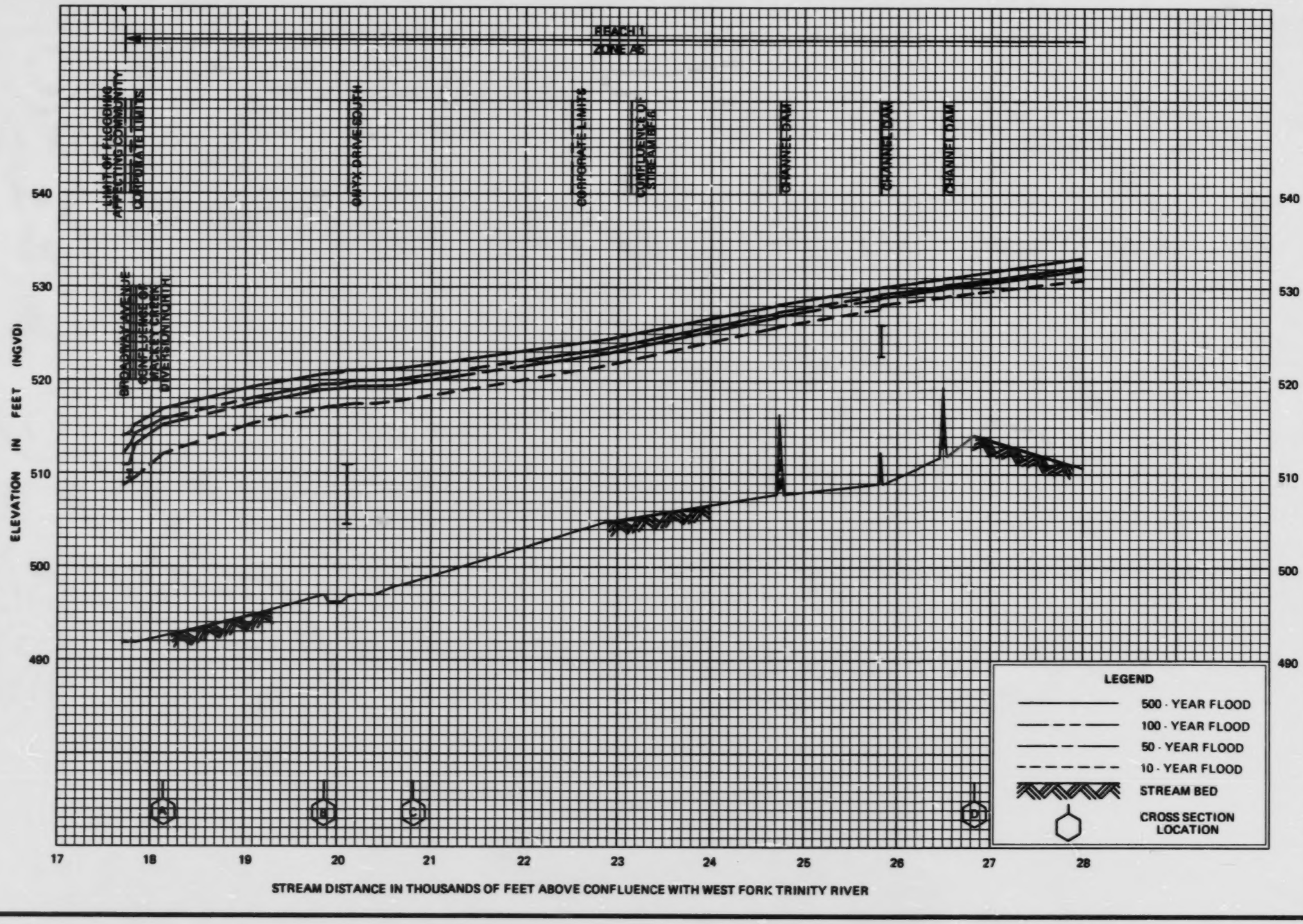
11. Federal Emergency Management Agency, Flood Insurance Study, City of North Richland Hills, Tarrant County, Texas, Washington, D. C., November 15, 1985.

12. Federal Emergency Management Agency, Flood Insurance Study, City of Keller, Tarrant County, Texas, Washington, D. C., September 30, 1982.

13. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Watauga, Tarrant County, Texas, Washington, D. C., June 1, 1982.

14. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Haltom City, Tarrant County, Texas, Washington, D. C., February 1, 1978.

15. Federal Emergency Management Agency, Flood Insurance Study, City of Hurst, Tarrant County, Texas, Washingotn, D. C., October 15, 1985.



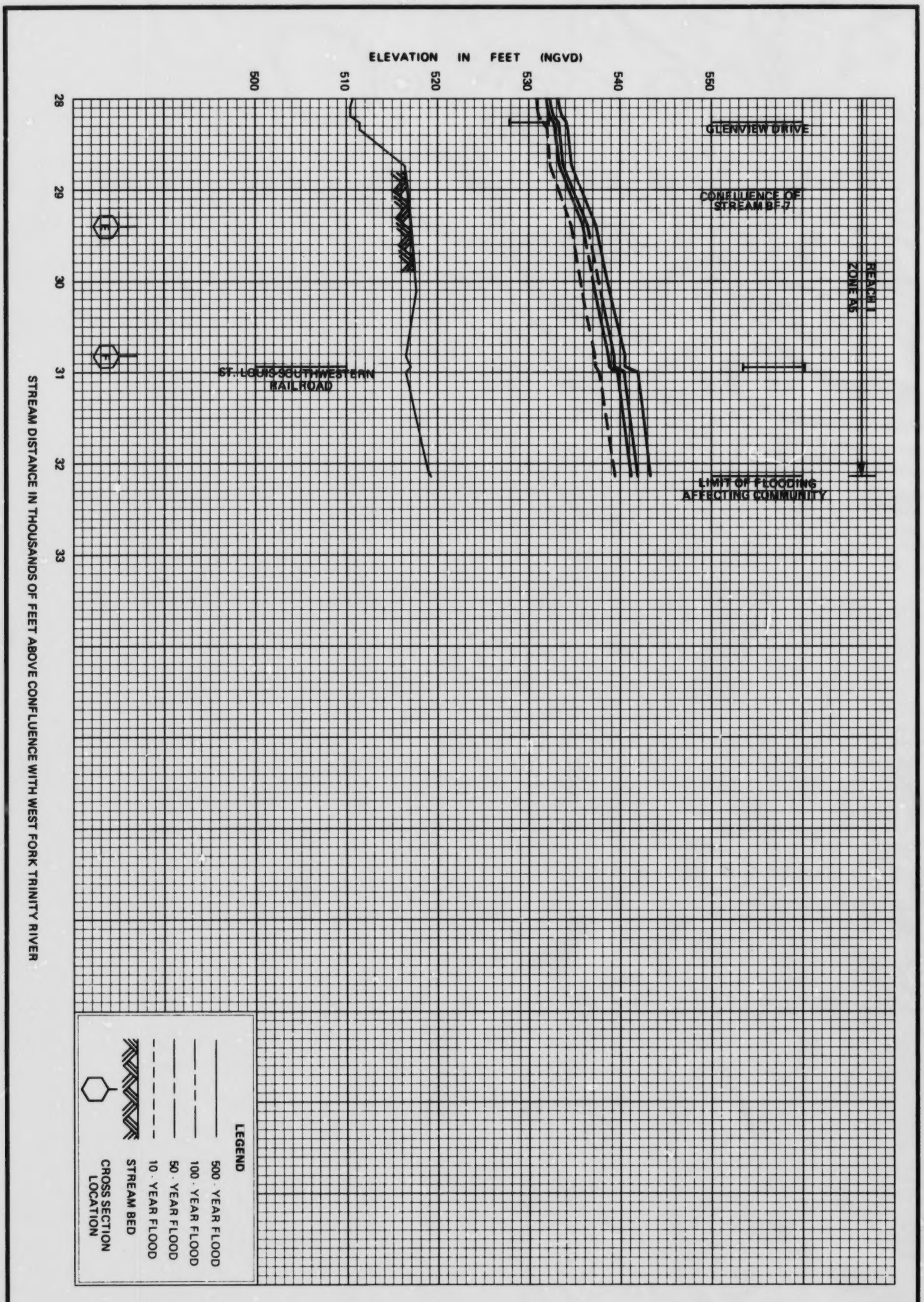
FLOOD PROFILES

BIG FOSSIL CREEK

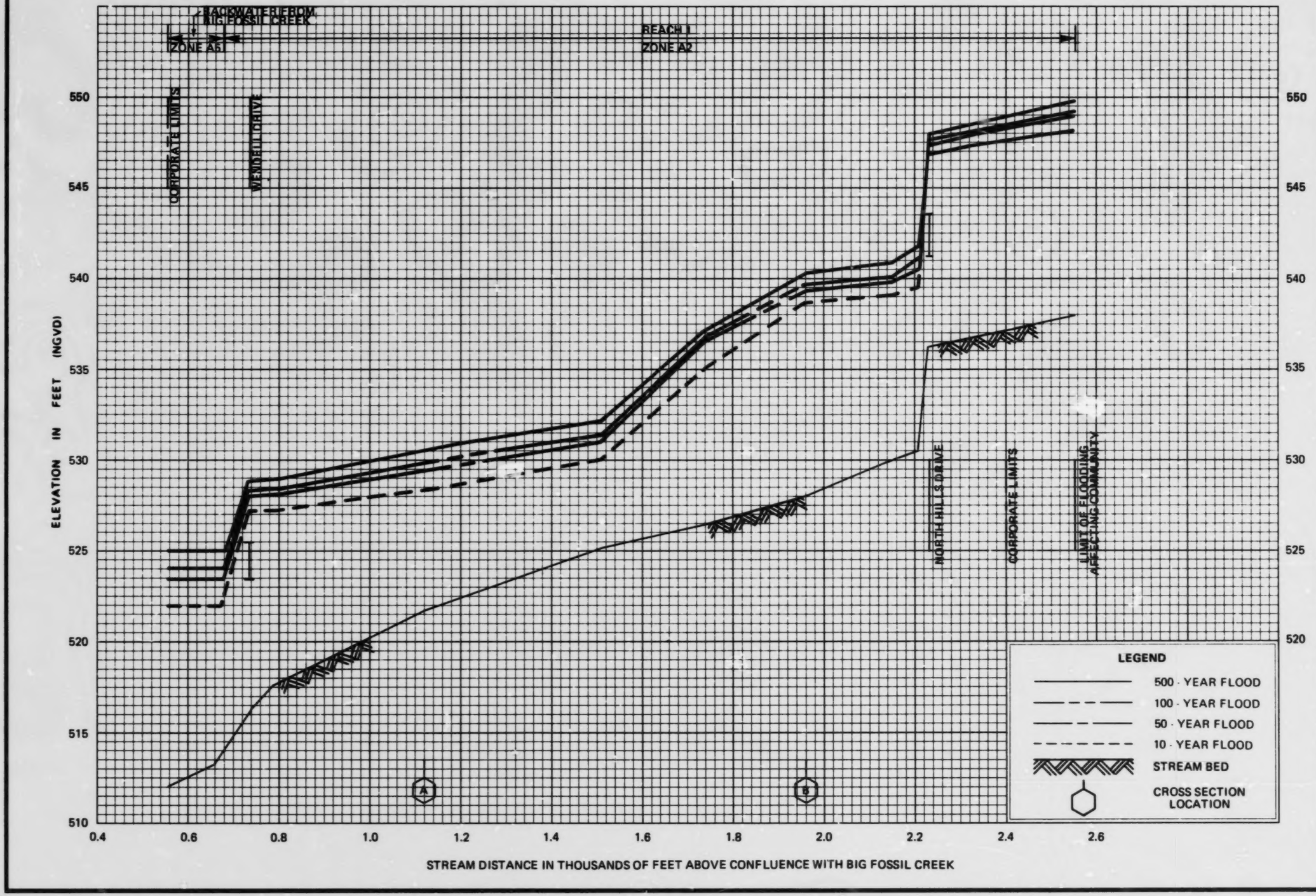
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

01P



02P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF NORTH RICHLAND HILLS, TX** (TARRANT CO.)	**FLOOD PROFILES** **BIG FOSSIL CREEK**



FLOOD PROFILES

STREAM BF-6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

03P

FLOODING CONTROLLED BY BIG FOSSIL CREEK
ZONE A5

BACKWATER FROM BIG FOSSIL CREEK
ZONE A5

CONFLUENCE WITH BIG FOSSIL CREEK

CORPORATE LIMITS

LIMIT OF DETAILED STUDY

ELEVATION IN FEET (NGVD)

540
535
530
525
520
515

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE WITH BIG FOSSIL CREEK

LEGEND

- 500 - YEAR FLOOD
- 100 - YEAR FLOOD
- 50 - YEAR FLOOD
- 10 - YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

STREAM BF-7

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

04P

REACH 1
ZONE A3

REACH 2
ZONE A4

REACH 3
ZONE A3

LIMIT OF FLOODING AFFECTING COMMUNITY

GLENVIEW DRIVE

CORPORATE LIMITS

BOOTH CALLOWAY ROAD

INTERSTATE ROUTE 820

STATE ROUTE 26

ELEVATION IN FEET (NGVD)

585
580
575
570
565
560
555
550
545
540

13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE WITH WALKER BRANCH

LEGEND

- 500 - YEAR FLOOD
- 100 - YEAR FLOOD
- 50 - YEAR FLOOD
- 10 - YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

CALLOWAY BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

05P

REACH 1
ZONE AE

INTERSTATE 820
INTERSTATE 820
INTERSTATE 820

MAPLEWOOD AVENUE

EDEN DRIVE

ELEVATION IN FEET (NGVD)

600
595
590
585
580
575
570
565

19.5 20.0 20.5 21.0 21.5 22.0 22.5 23.0 23.5 24.0 24.5 25.0 25.5 26.0

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE WITH WALKER BRANCH

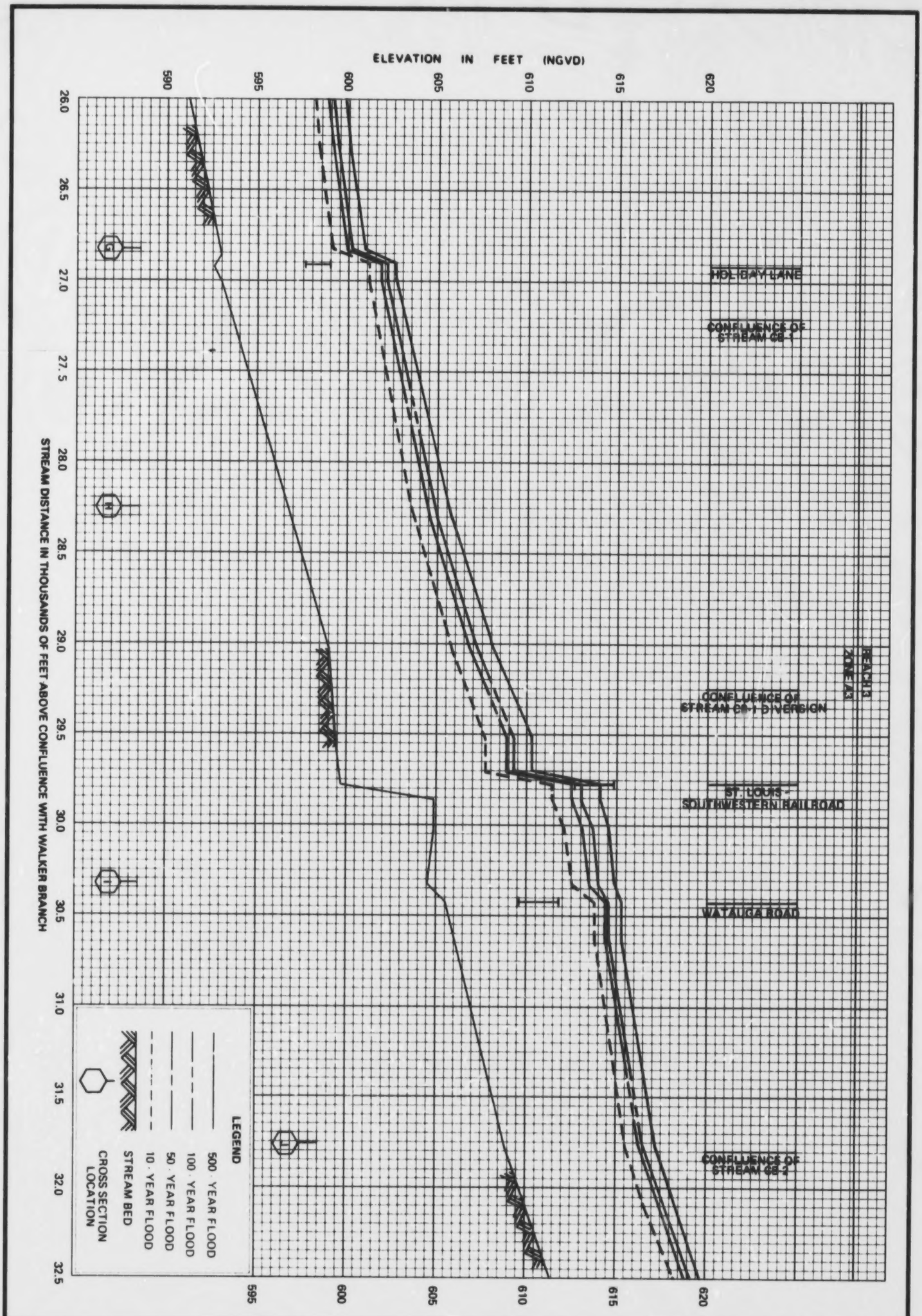
LEGEND
- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

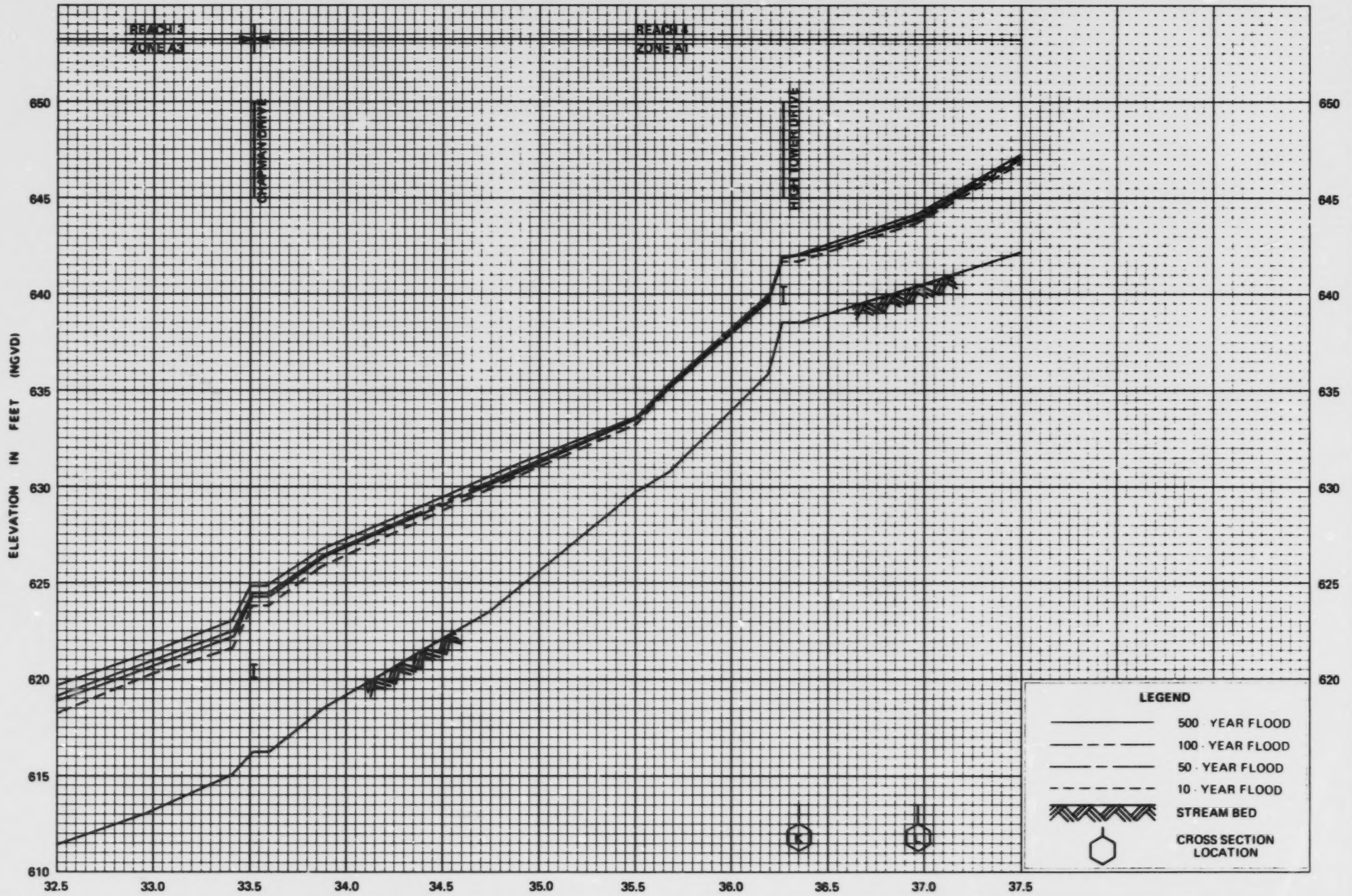
CALLOWAY BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

06P



07P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF NORTH RICHLAND HILLS, TX** (TARRANT CO.)	**FLOOD PROFILES** **CALLOWAY BRANCH**



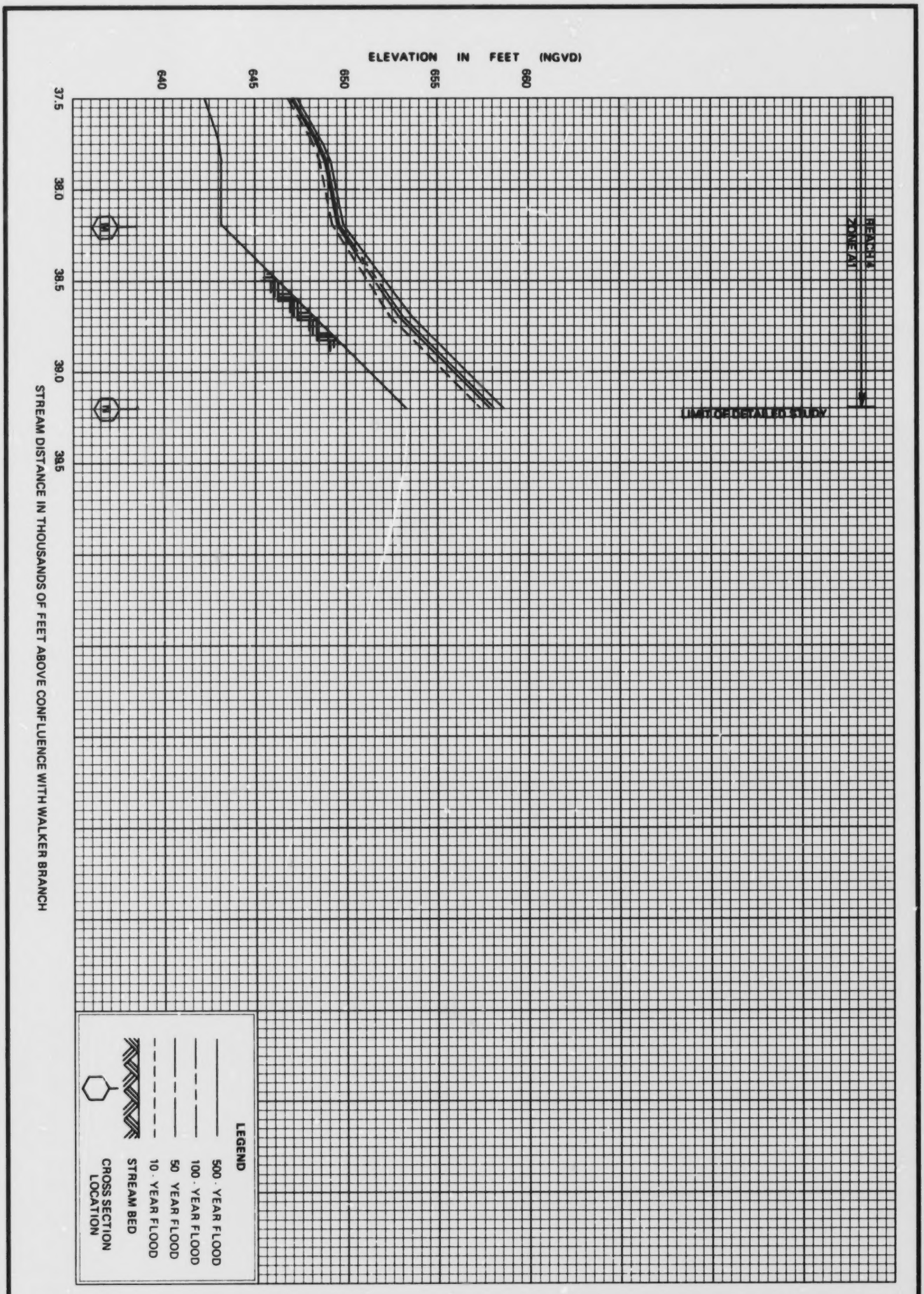
FLOOD PROFILES

CALLOWAY BRANCH

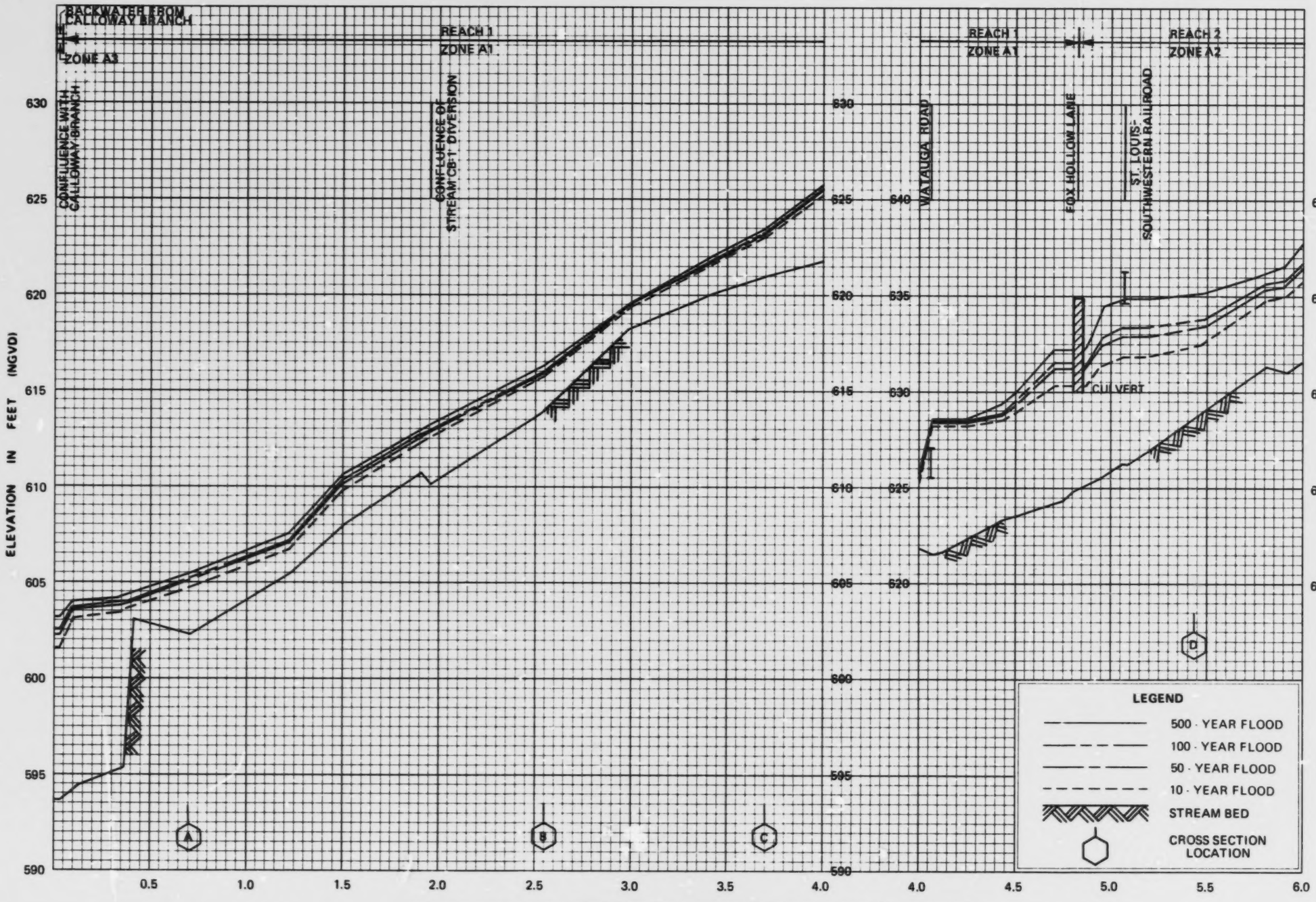
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

08P



09P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF NORTH RICHLAND HILLS, TX** (TARRANT CO.)	**FLOOD PROFILES** **CALLOWAY BRANCH**



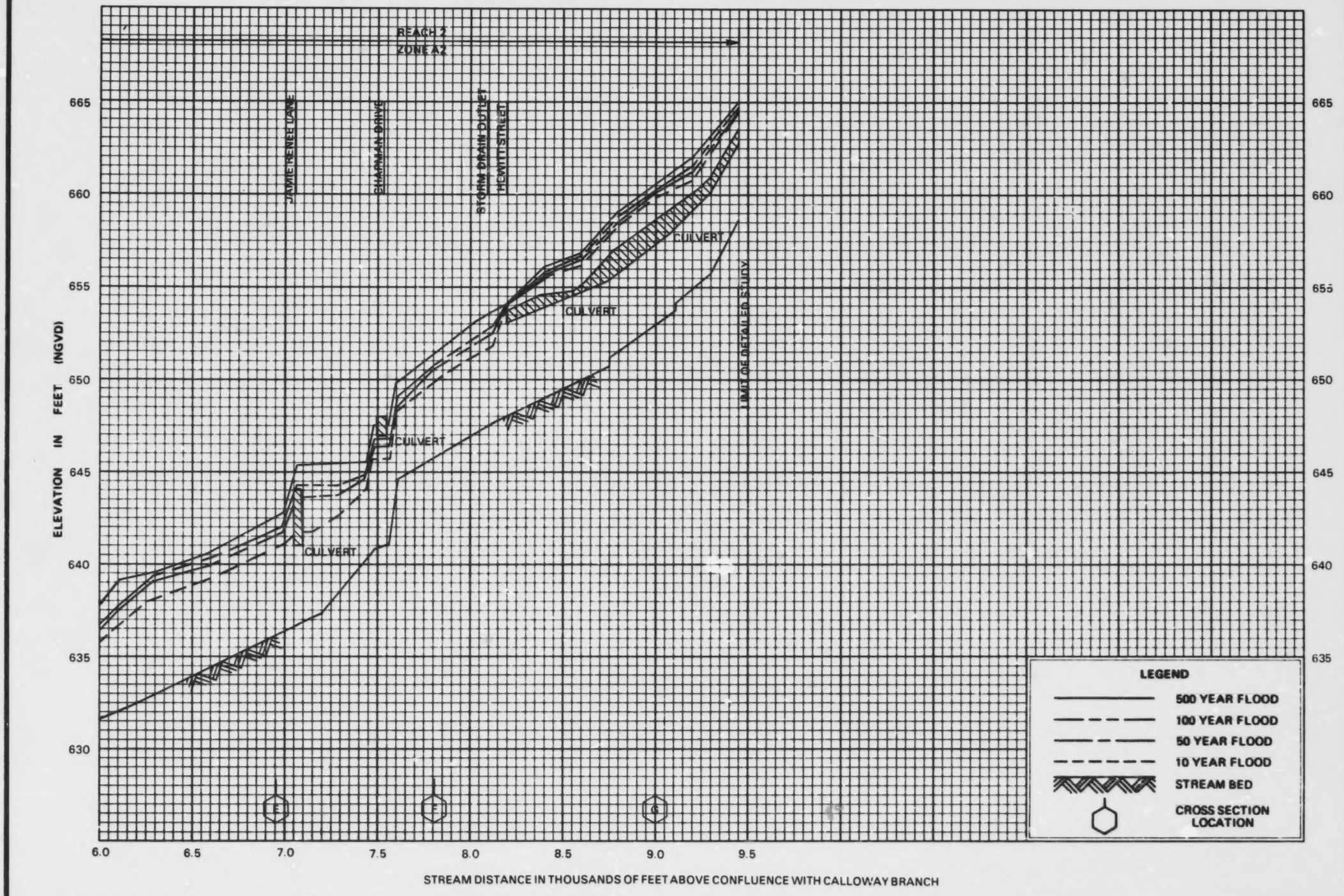
FLOOD PROFILES

STREAM CB-1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

10P



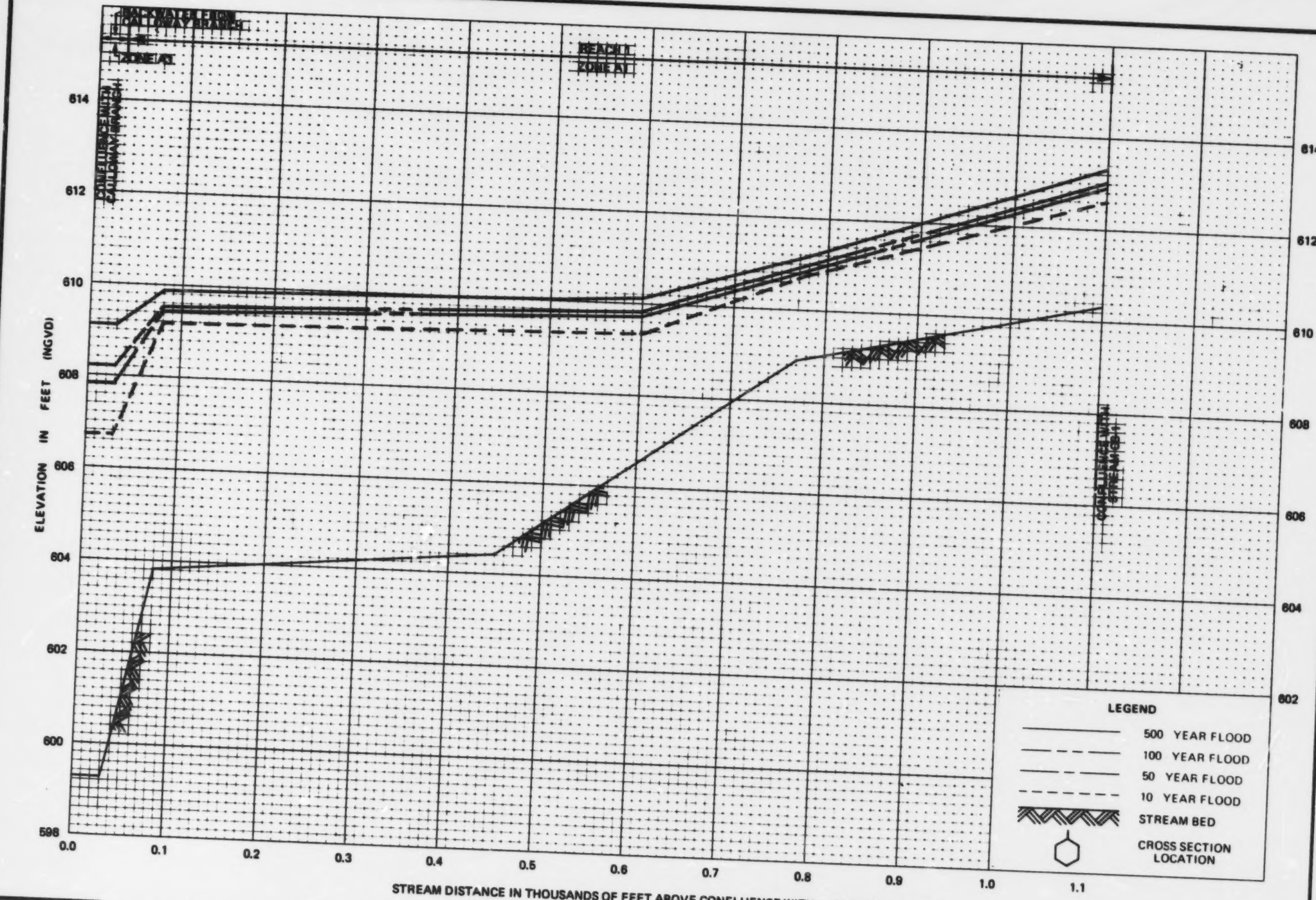
FLOOD PROFILES

STREAM CB-1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

11P



FLOOD PROFILES

STREAM CB-1 DIVERSION

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

12P

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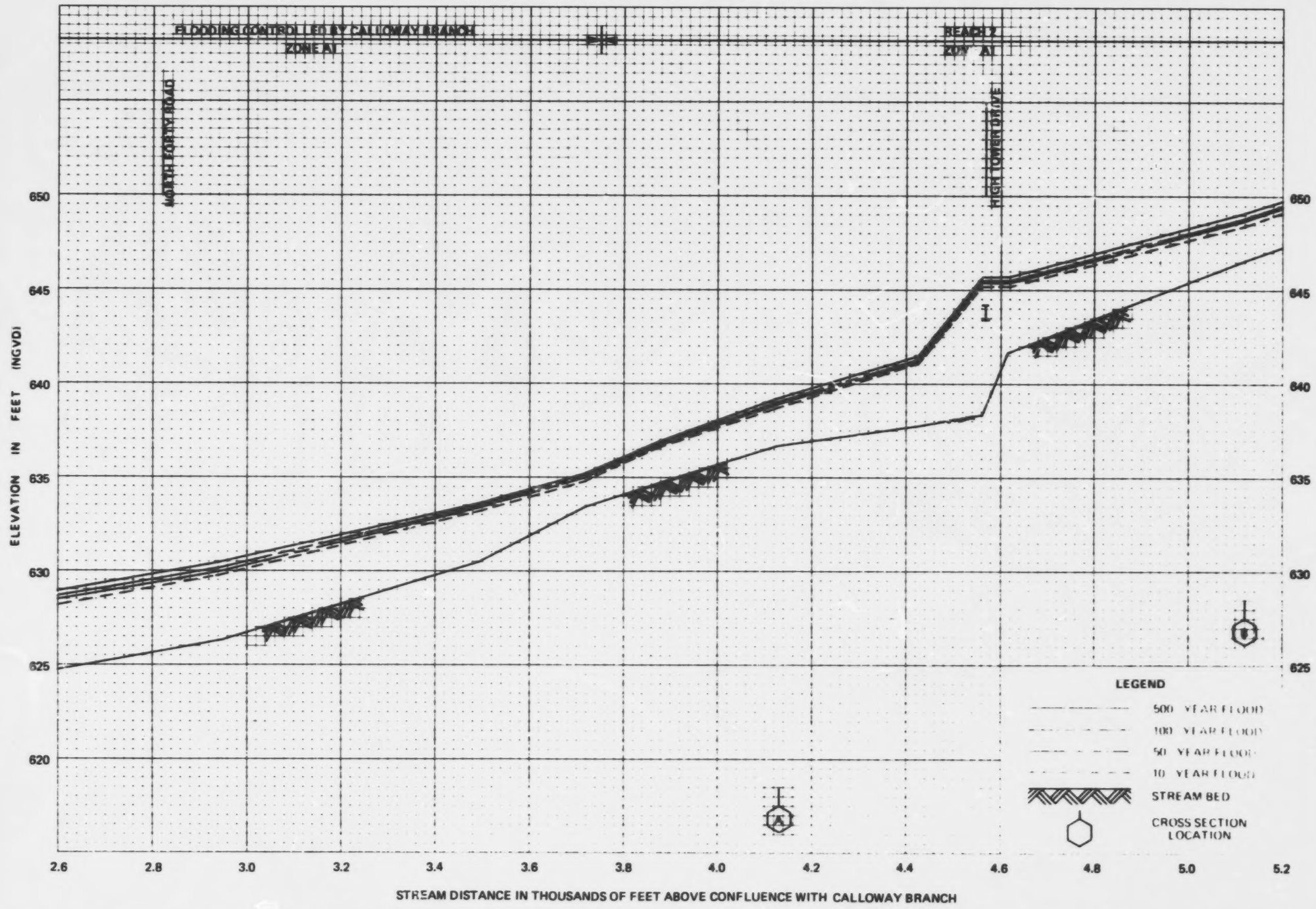
FLOOD PROFILES

STREAM CB-2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

13P



FLOOD PROFILES

STREAM CB-2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

14P

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REACH 2
ZONE AH

LIMIT OF DETAILED STUDY

THE 50-YEAR FLOOD PROFILE IS TOO CLOSE TO THE 100-YEAR ELEVATION TO BE SHOWN SEPARATELY

ELEVATION IN FEET (NGVD)

675
670
665
660
655
650
645

5.2 5.4 5.6 5.8 6.0 6.2 6.4 6.6 6.8 7.0 7.2 7.4

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE WITH CALLOWAY BRANCH

LEGEND

- 500 - YEAR FLOOD
- 100 - YEAR FLOOD
- 50 - YEAR FLOOD
- 10 - YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

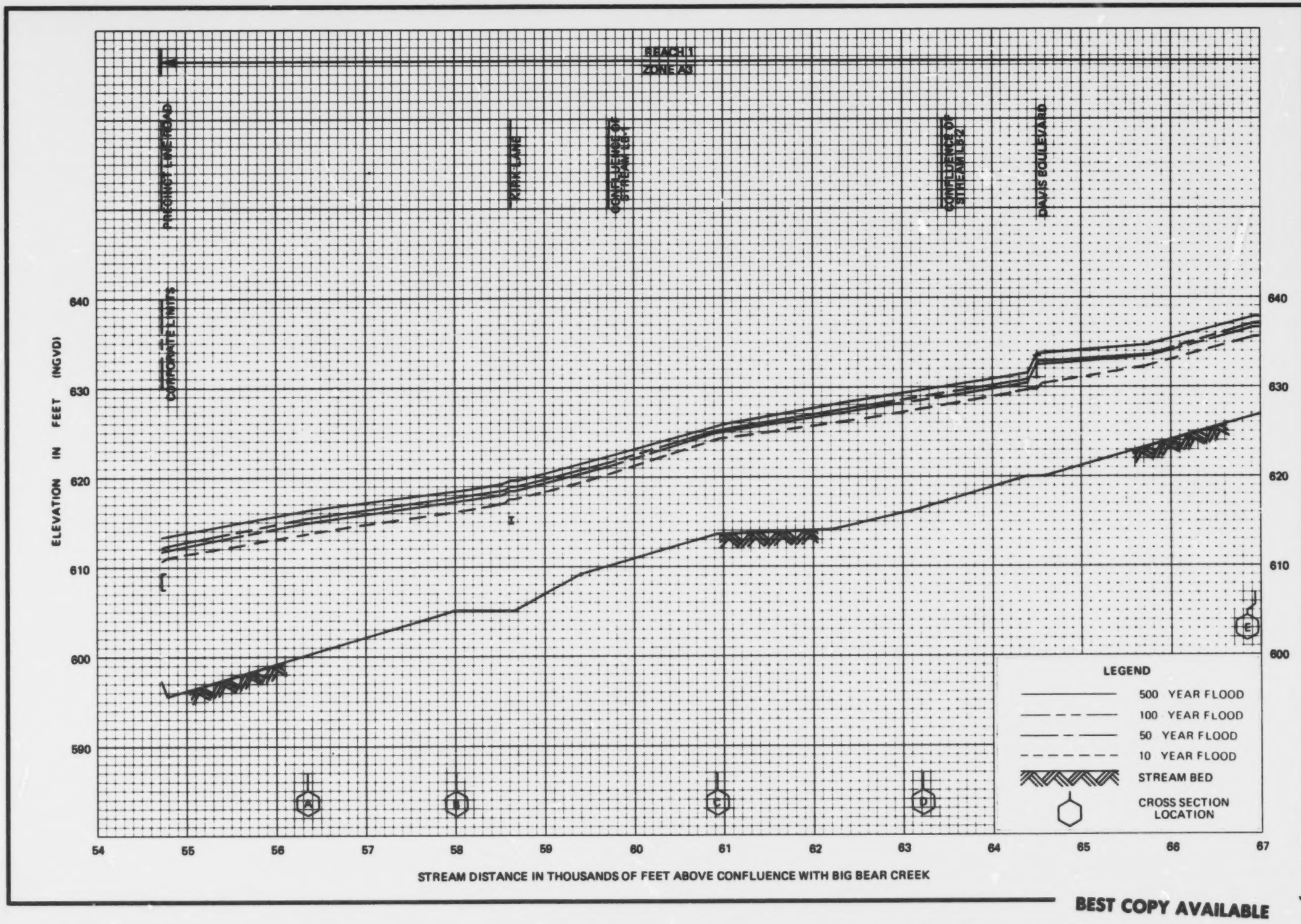
FLOOD PROFILES

STREAM CB-2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

15P



FLOOD PROFILES

LITTLE BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

16P

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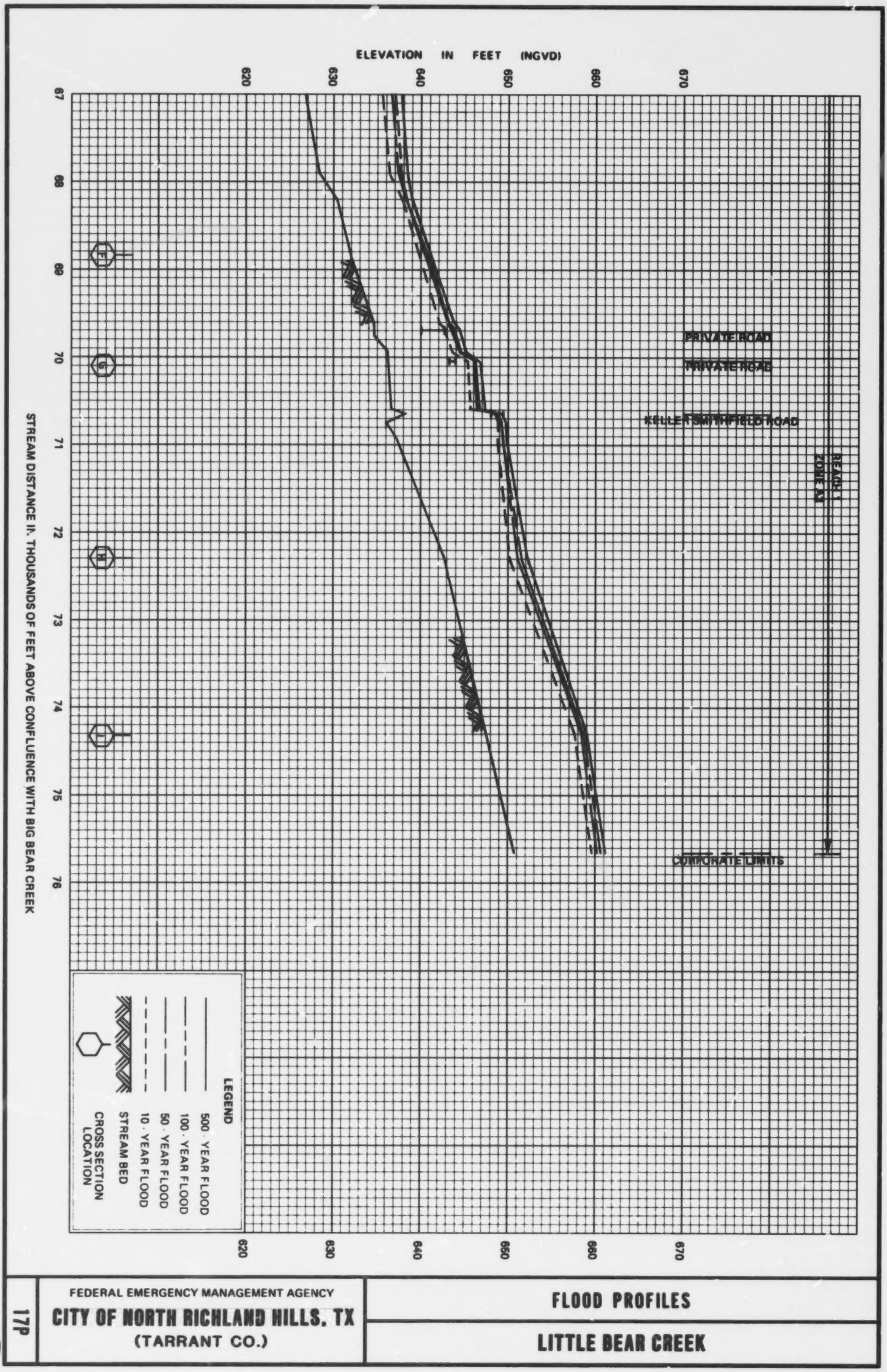


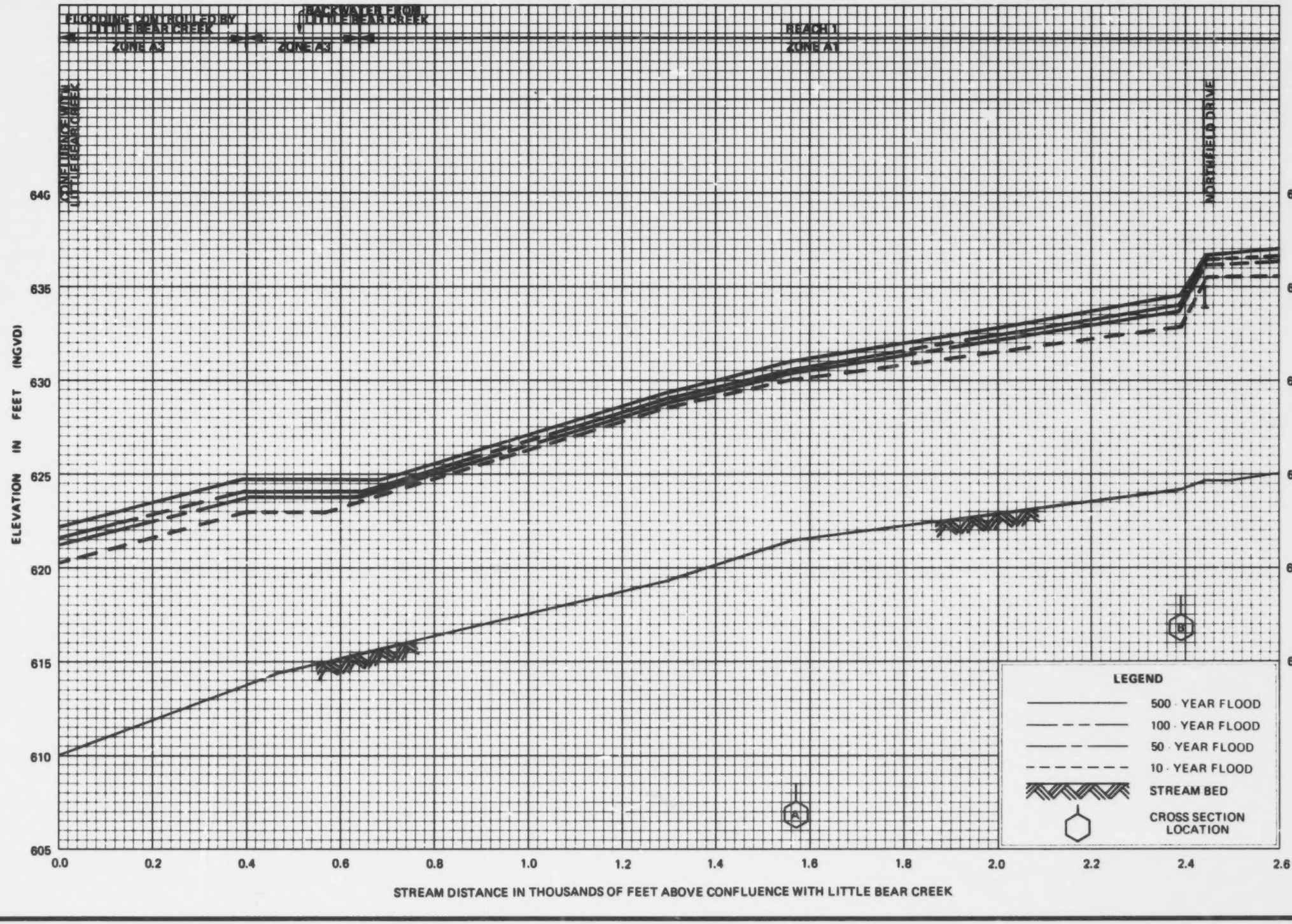
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

17P

FLOOD PROFILES

LITTLE BEAR CREEK



FLOOD PROFILES

STREAM LB-1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

18P

REACH 1
ZONE AI

LIMIT OF DETAILED STUDY

650
645
640
635
630
625
620

ELEVATION IN FEET (NGVD)

650
645
640
635
630
625

2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE WITH LITTLE BEAR CREEK

LEGEND

- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

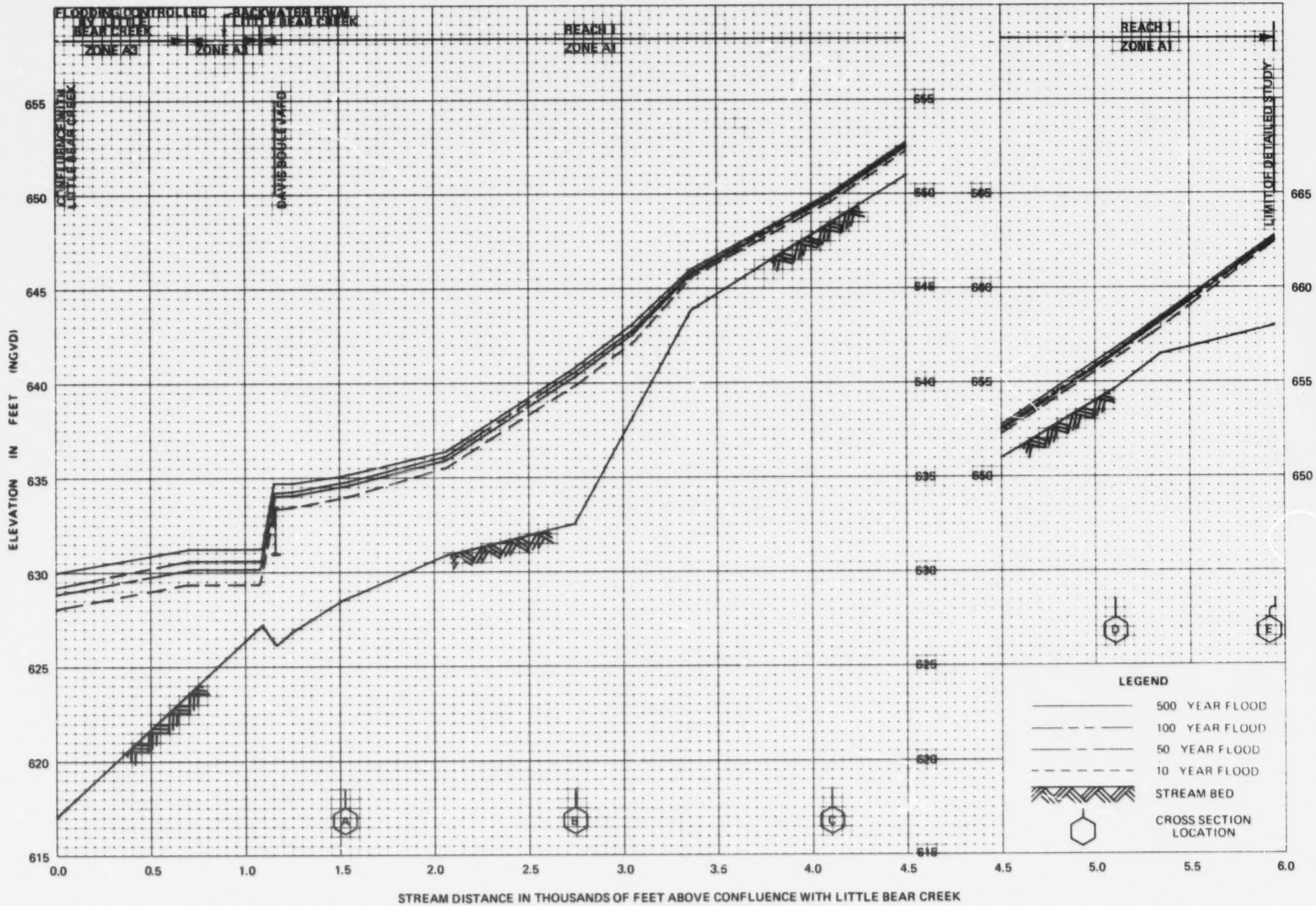
FLOOD PROFILES

STREAM LB-1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

19P



FLOOD PROFILES

STREAM LB-2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

20P

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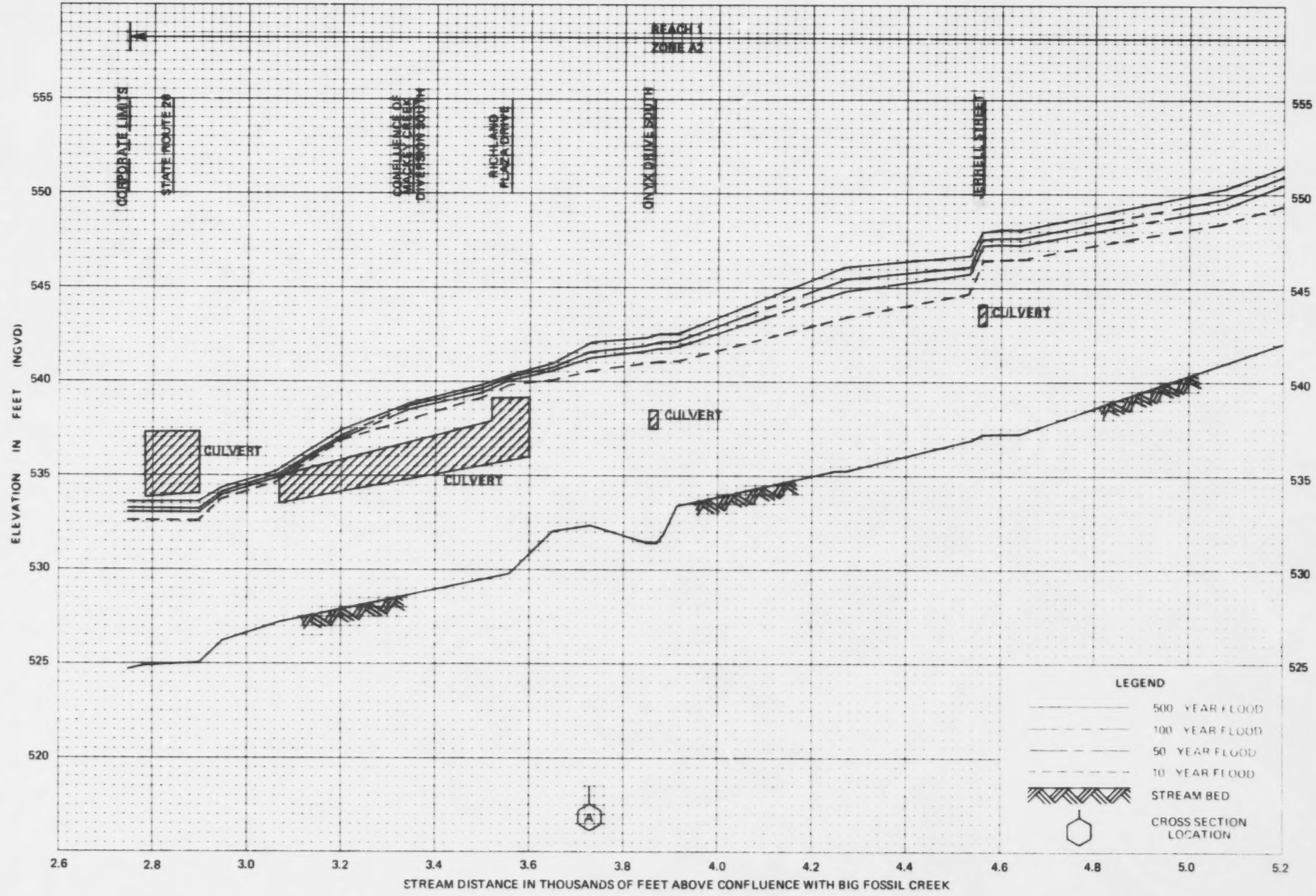

FLOOD PROFILES

MACKEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

21P

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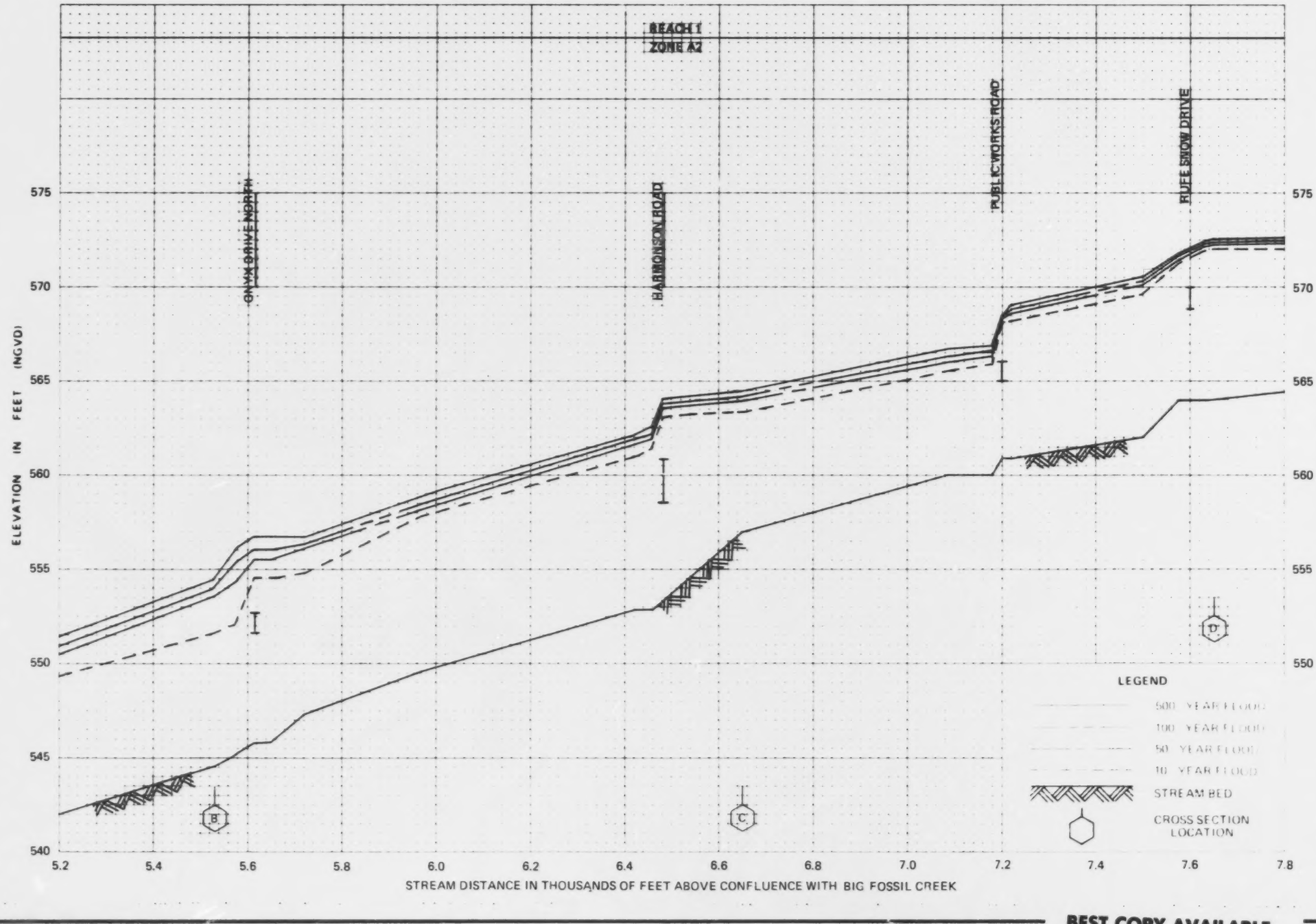

FLOOD PROFILES

MACKEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

22P

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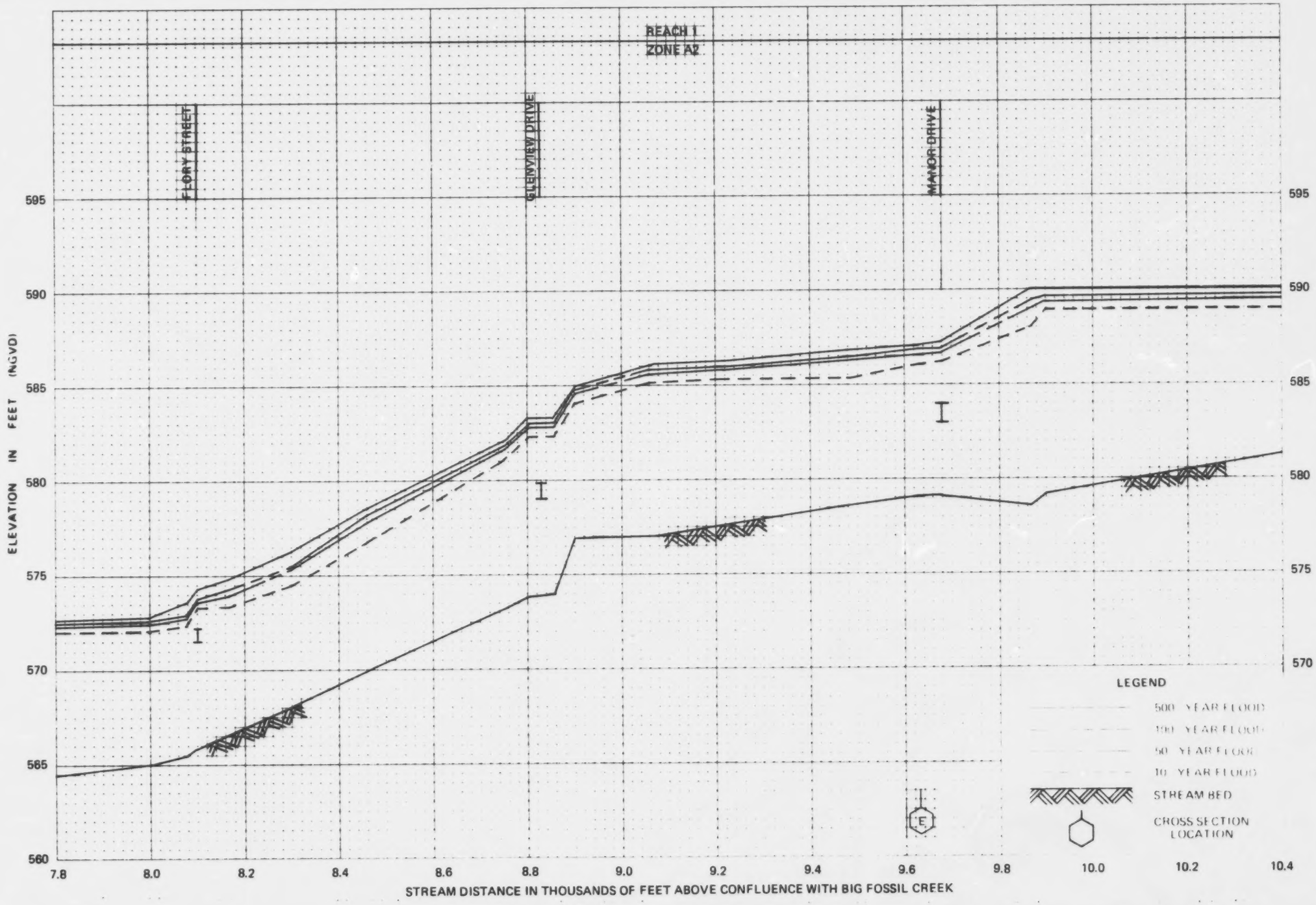

FLOOD PROFILES

MACKEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

23P

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FLOOD PROFILES

MACKEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

24P

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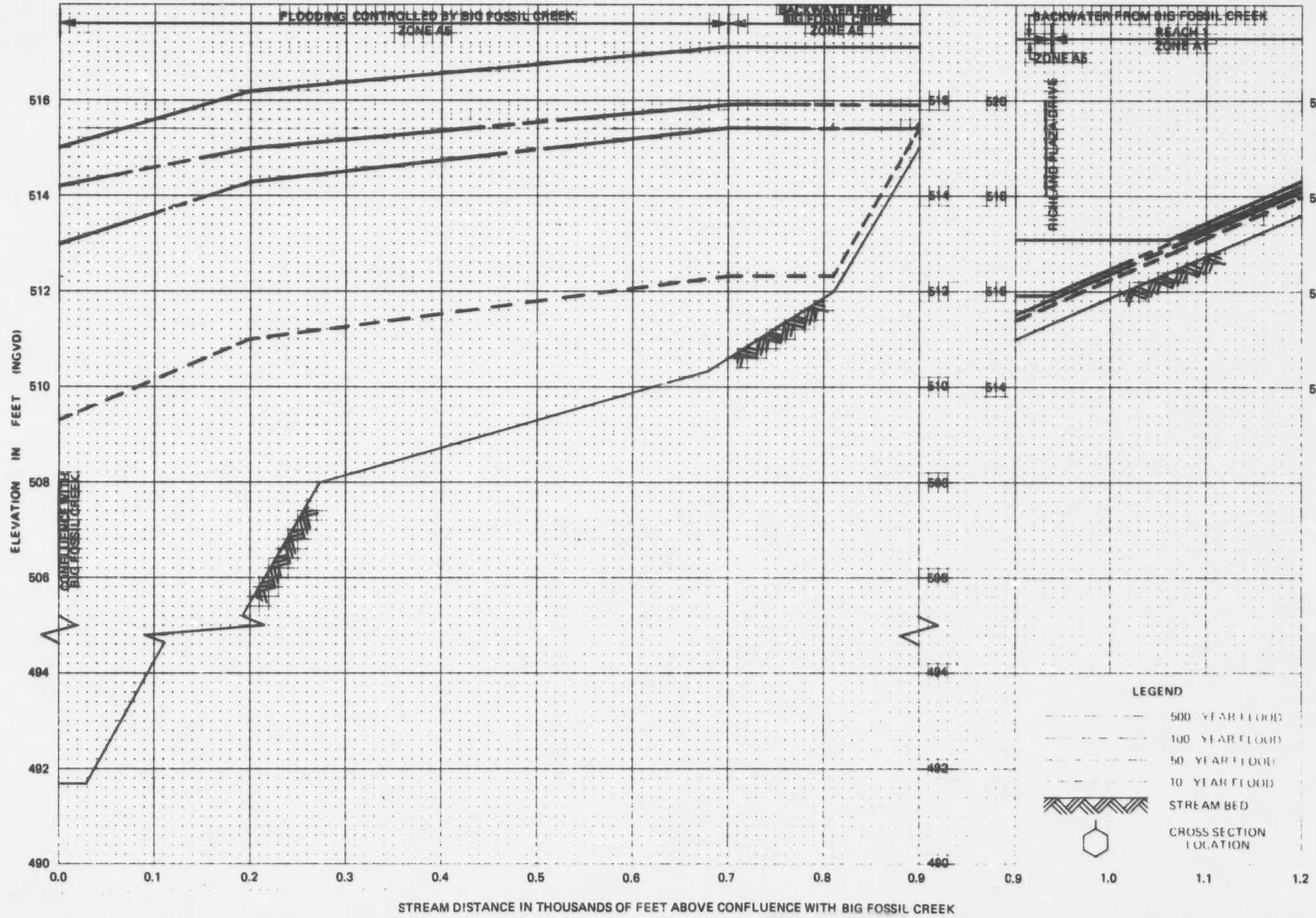

FLOOD PROFILES

MACKEY CREEK DIVERSION NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

25P

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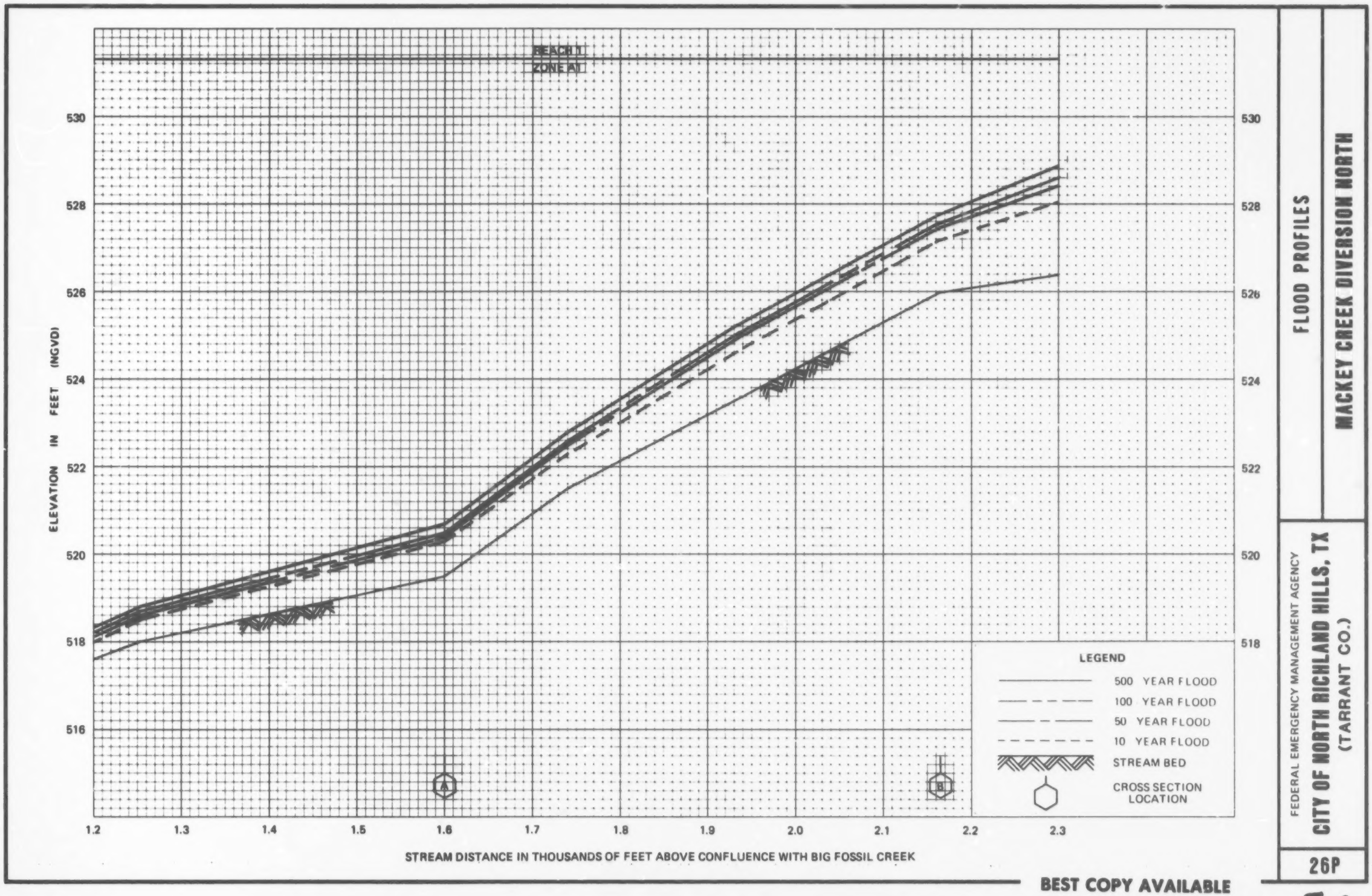

FLOOD PROFILES

MACKEY CREEK DIVERSION NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

26P

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FLOOD PROFILES

MACKEY CREEK DIVERSION NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

27P

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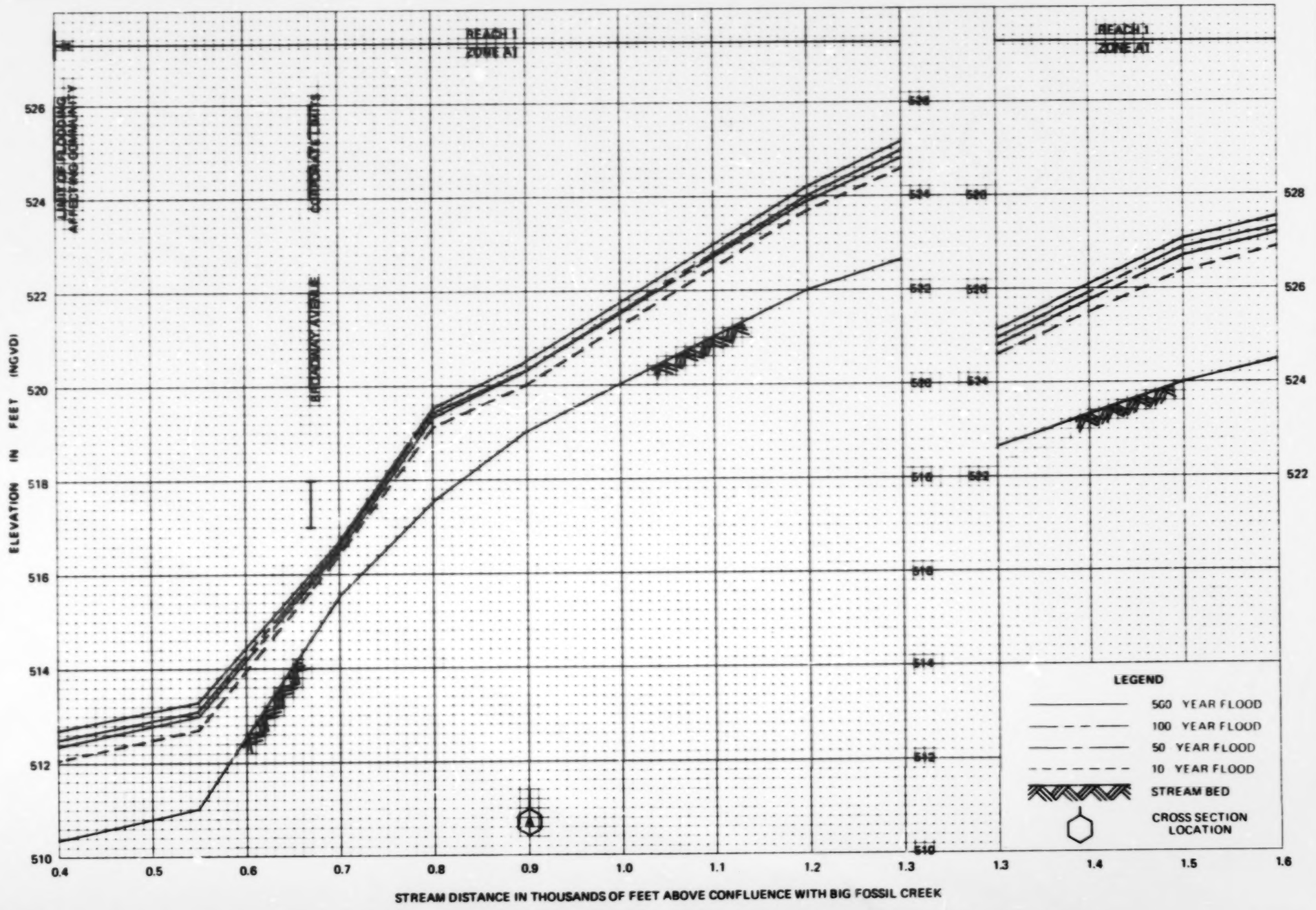

FLOOD PROFILES

MACKEY CREEK DIVERSION SOUTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

28P

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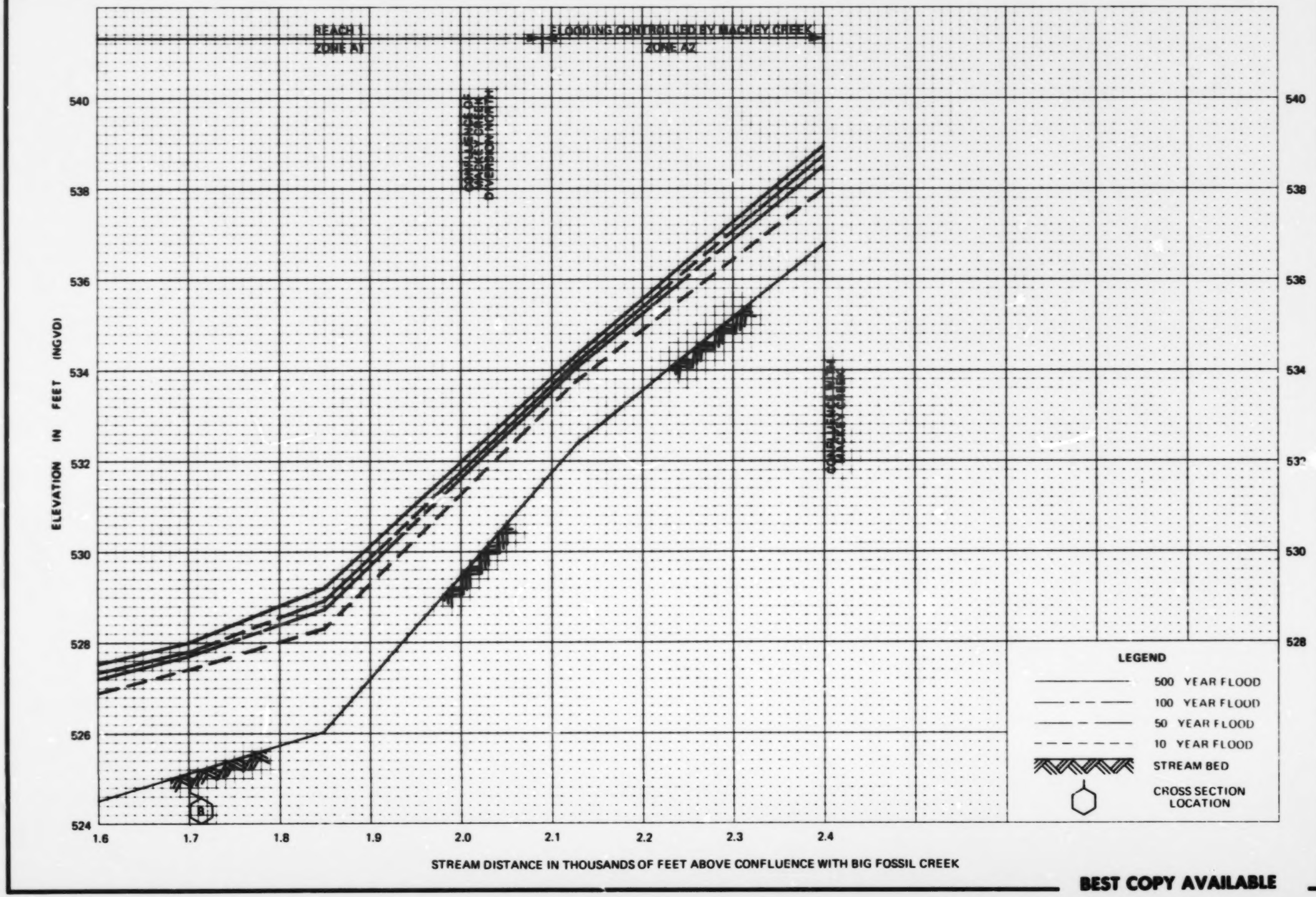

FLOOD PROFILES

MACKEY CREEK DIVERSION SOUTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

29P

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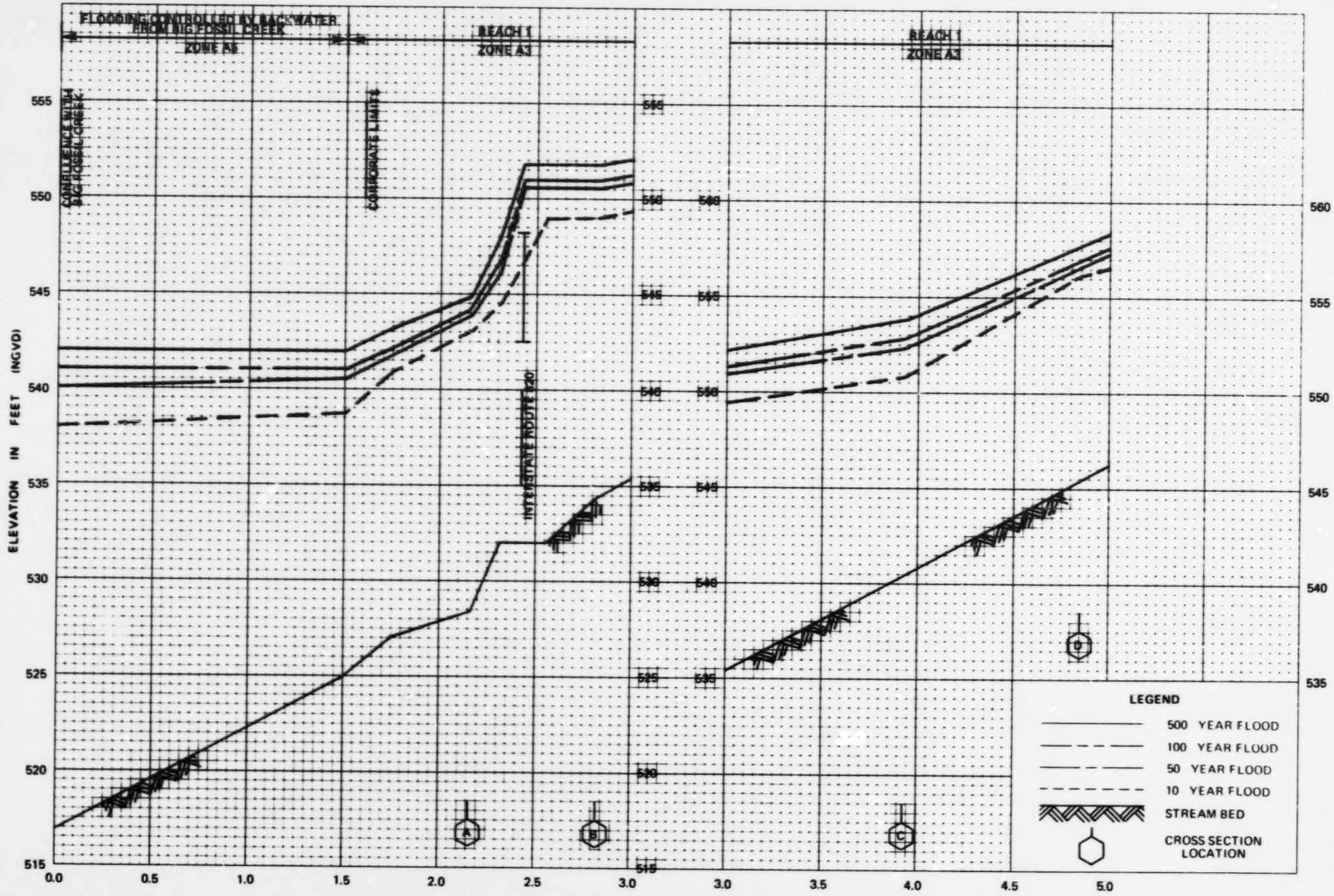

FLOOD PROFILES

SINGING HILLS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

30P

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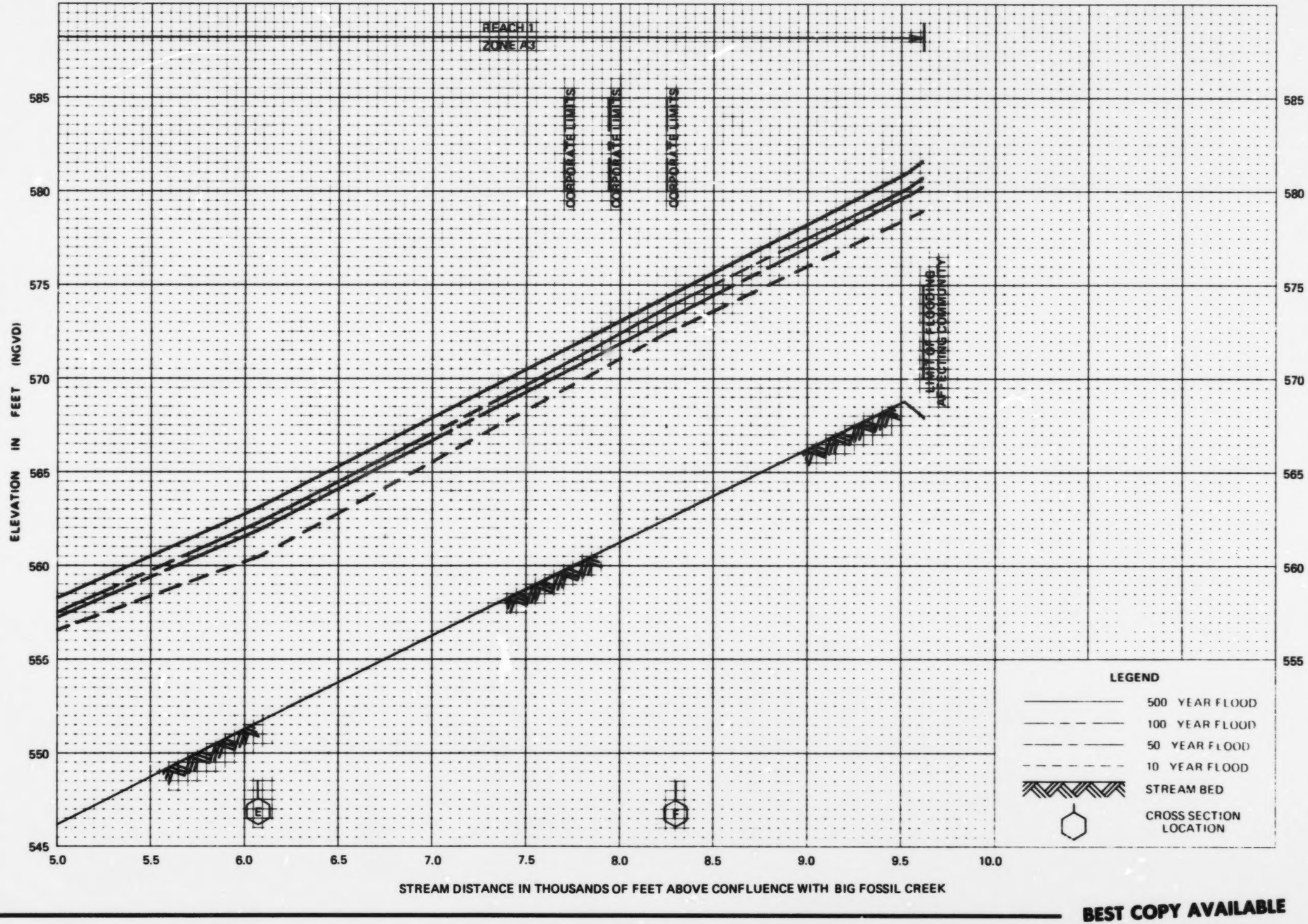

FLOOD PROFILES

SINGING HILLS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

31P

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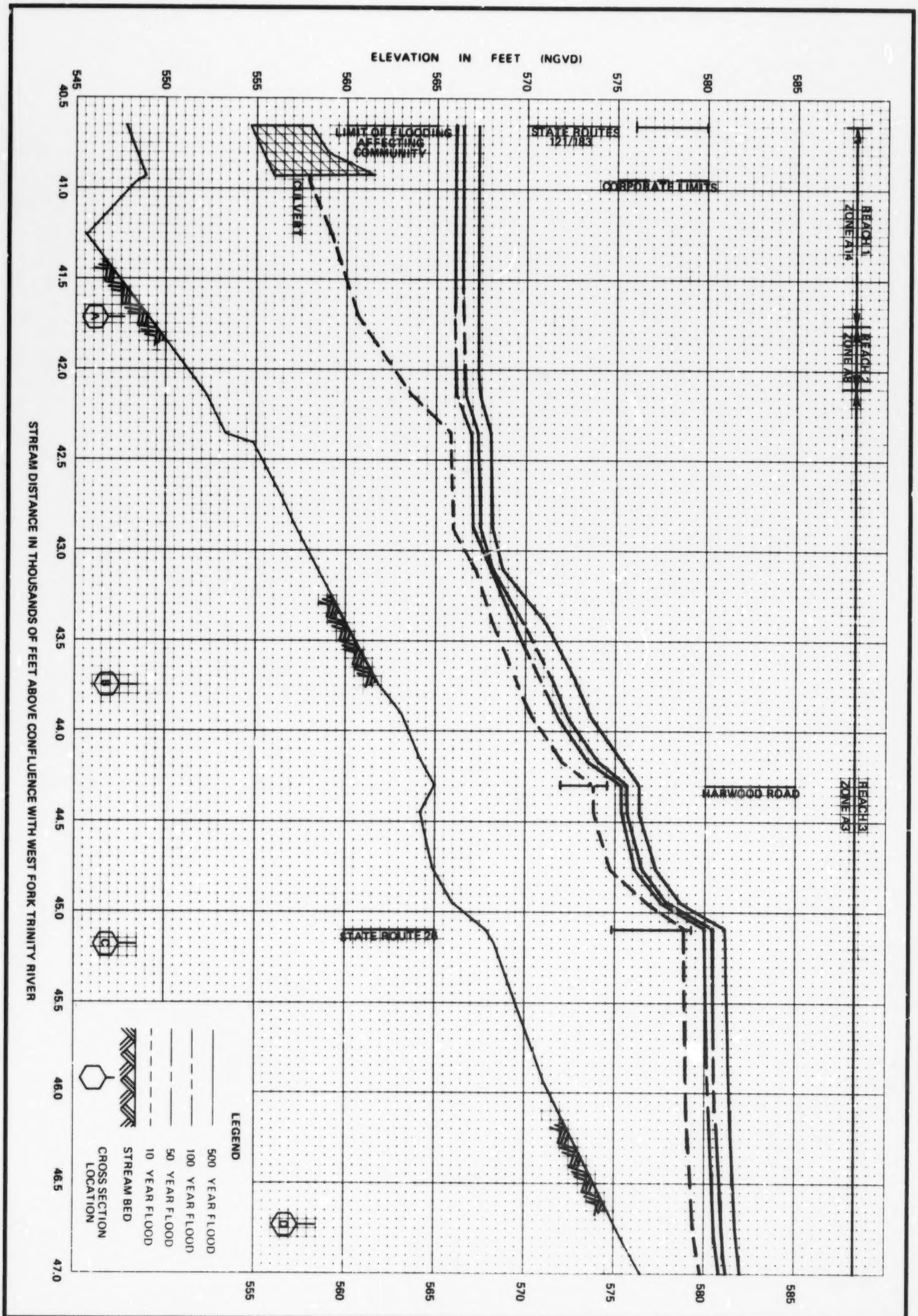


32P

FEDERAL EMERGENCY MANAGEMENT AGENCY

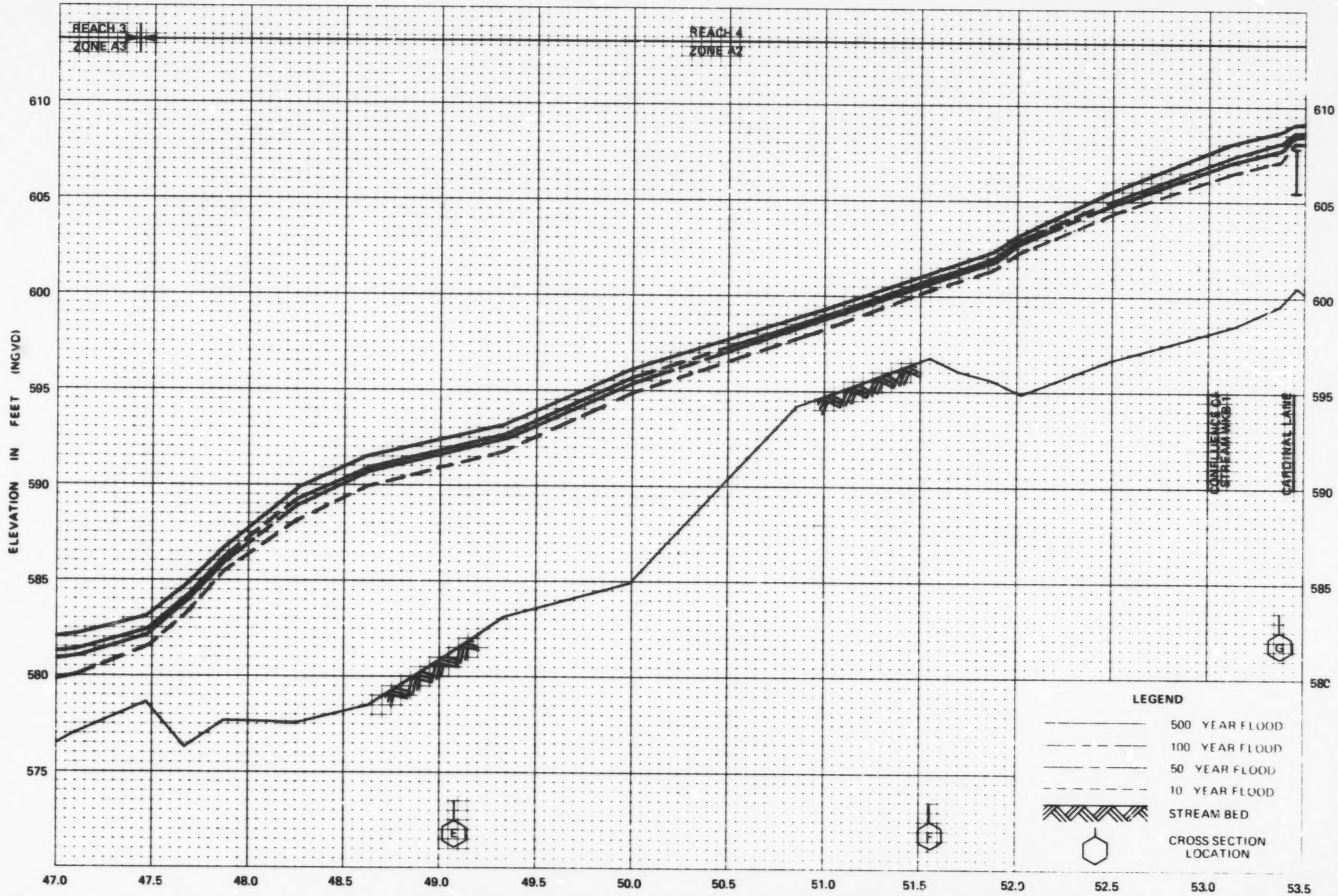
CITY OF NORTH RICHLAND HILLS, TX

(TARRANT CO.)

FLOOD PROFILES

WALKER BRANCH

60



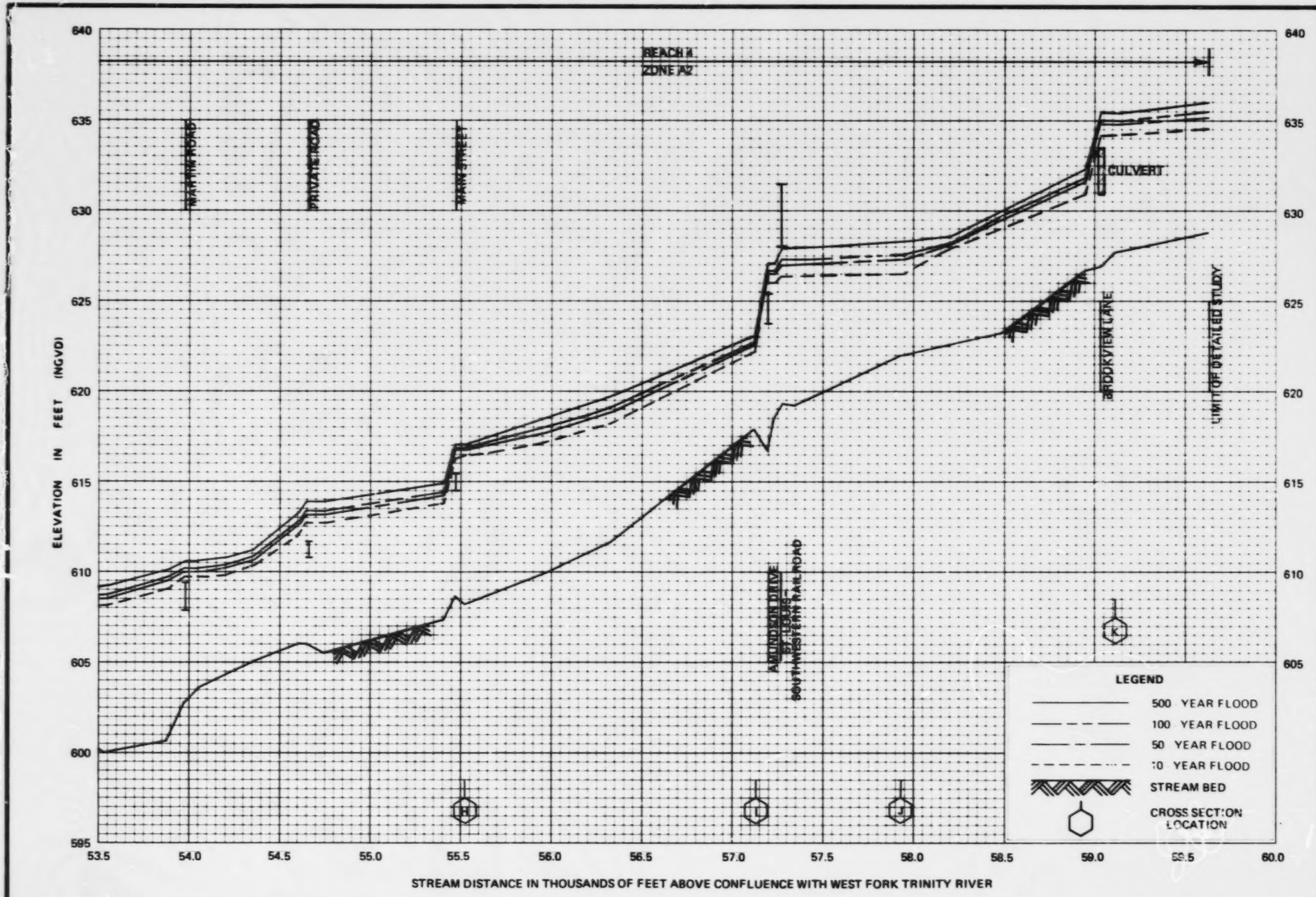
FLOOD PROFILES

WALKER BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

33P



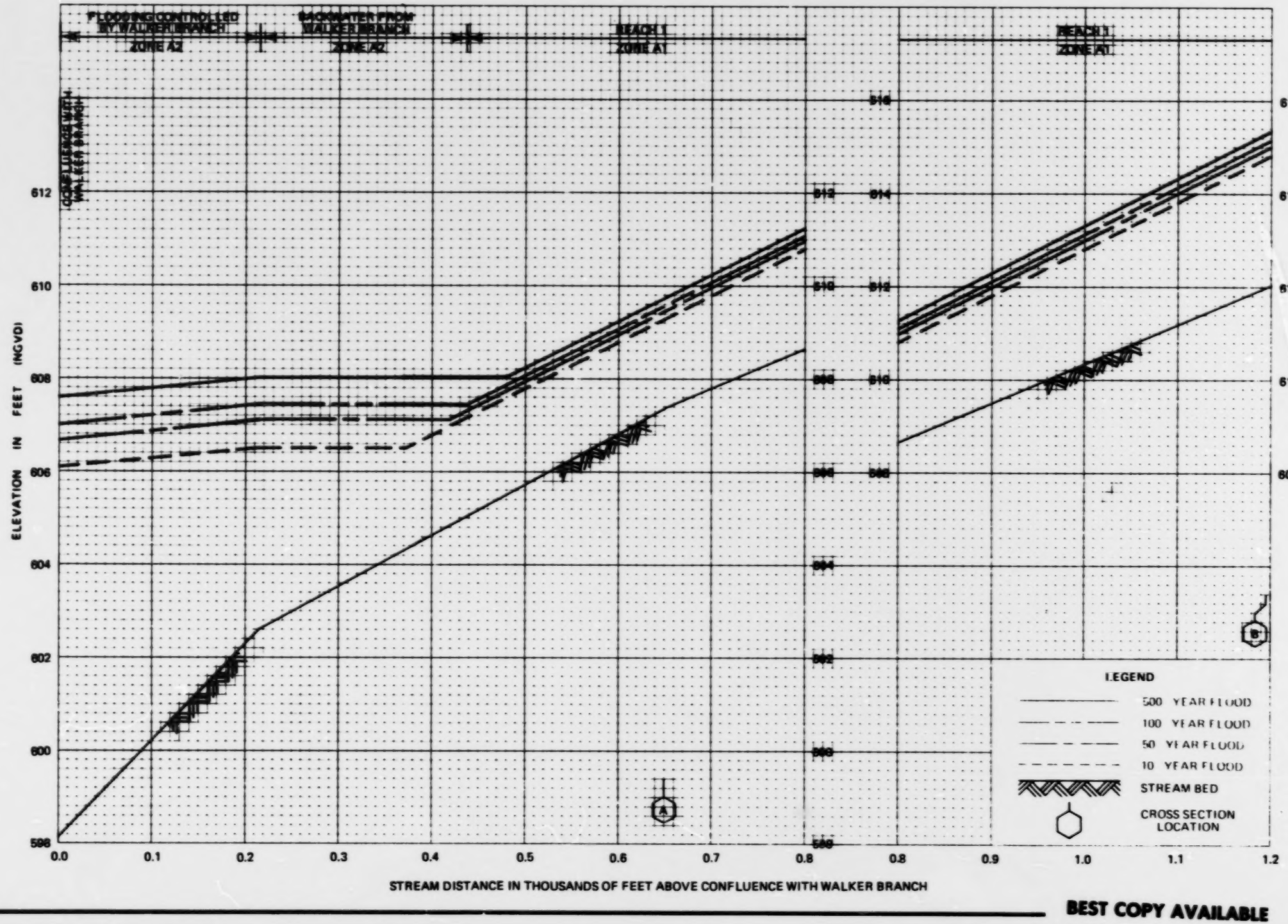
FLOOD PROFILES

WALKER BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

34P



FLOOD PROFILES

STREAM WKB-1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

35P

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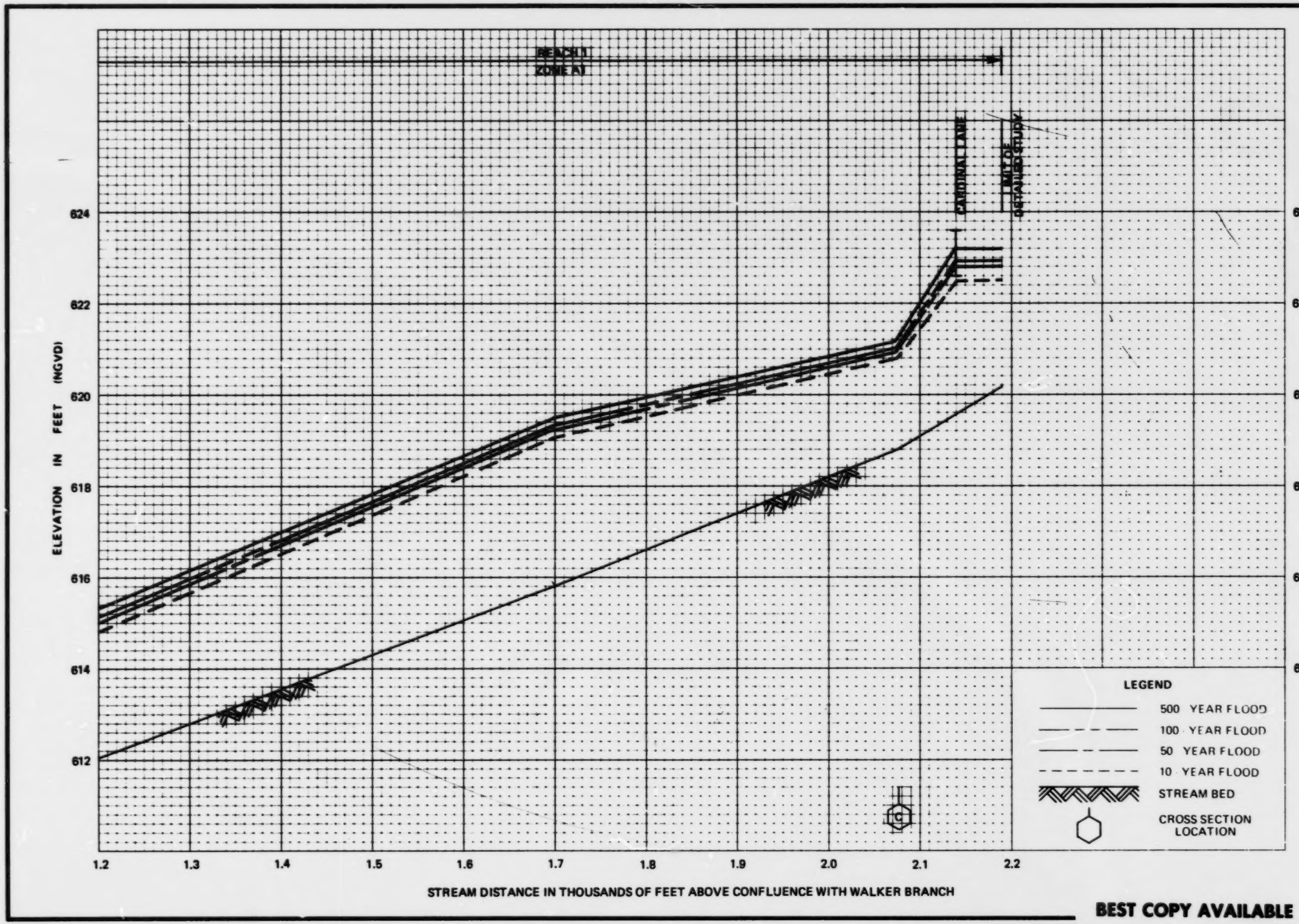

FLOOD PROFILES

STREAM WKB-1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF NORTH RICHLAND HILLS, TX
(TARRANT CO.)

36P

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